POWER PLANT ENGINEERING

Established Over 29 Years

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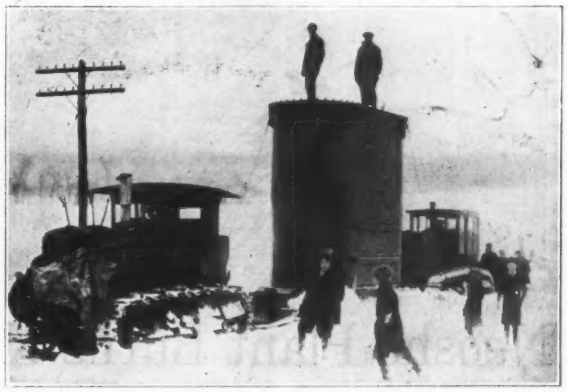
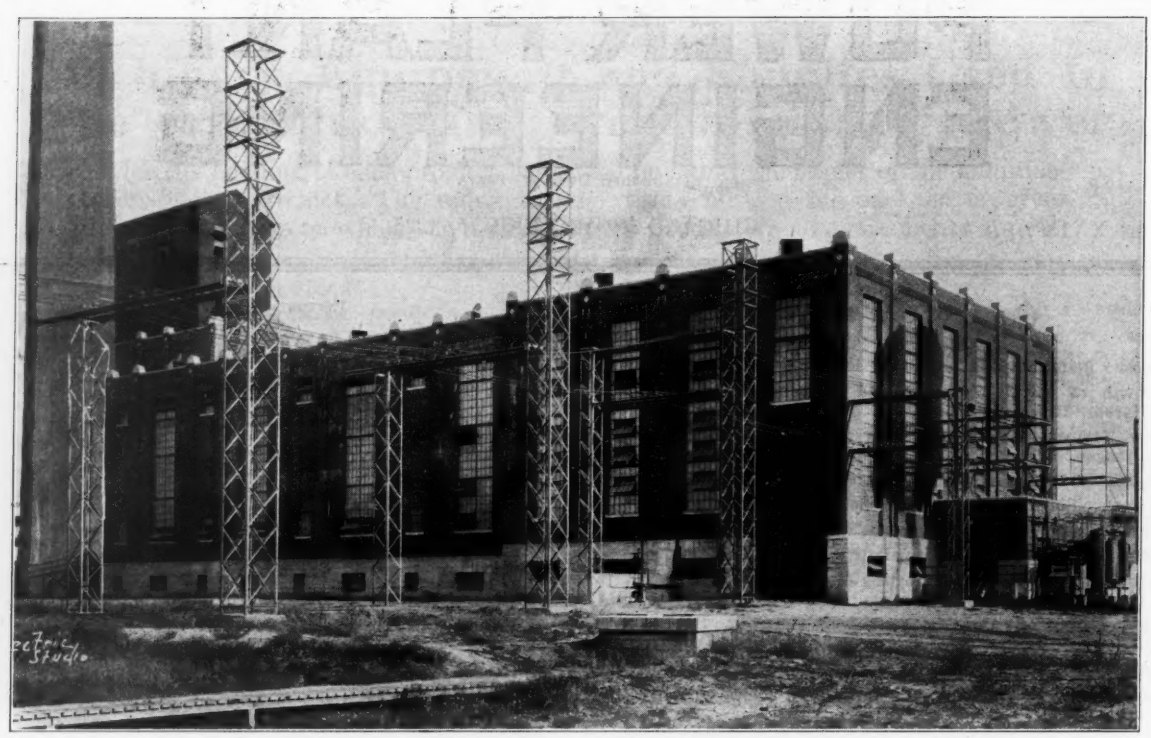


Snow Bound?

NO, SUBSTATION BOUND, with the substation three miles away. Transporting this 110,000-v., 30,000-kv.a. auto transformer three miles from the railroad to the substation in the dead of winter was not what is commonly termed a "snap" and was a task which required considerable courage on the part of those who did it. The highway traversed several hills and a bridge. The hills were strong enough but the bridge was not, so first before the procession started, the bridge had to be strengthened. This done, the whole performance went off like a charm. On a specially constructed sled pulled and pushed by two 10-t. tractors, this 67-t. mass of copper and iron was hauled to its destination in nine hours. Winter construction, now being advocated by Mr. Hoover, may at times present difficulties but they are never so great but that with a little engineering skill and good common sense they cannot be overcome.

DID YOU EVER, when starting a motor, allow the control arm on the old-time starting box to linger between two contact points? Pretty, wasn't it, to see the sizzling, green arc dance, first to one side, then to the other, growing ever larger, lighting up the room with a dazzling emerald glow? True, it played the Devil with the contact points, but it was pretty to see and when anything is pretty, many things are excusable. With modern starting boxes, however, we can't amuse ourselves in this way for the arc's existence is doomed from the start. Not only are numerous devices provided to prevent its formation, but even when it does form, an ever-watchful magnetic field blows it so far it takes a week of Sundays to get back. Some of the trials and tribulations of an arc in a modern starting box are discussed by Charles S. Green in this issue.



Neosho Plant Burns Kansas Coal Economically

PRESENT-DAY COMBUSTION METHODS AND GREATER RELIABILITY OF SUPPLY GIVE COAL PREFERENCE OVER OIL AND NATURAL GAS FOR PLANT OF KANSAS GAS & ELECTRIC CO.

KANSAS IS A particularly fortunate state in that it harbors within its borders an unusually complete assortment of fuels. The designing engineer for a plant in that state is not alone confronted with the problem of how best a certain fuel can be used, but he must first make a selection of the kind of fuel which, in his opinion, will prove to be the most economical. Analysis of the present fuel situation is not sufficient. The problem must be studied from the viewpoint of the demand and supply of the future as well as that of the present.

Coal, of not a high grade, is plentiful in Kansas. The extent to which it can be mined is estimated to a fair degree of accuracy. Oil and gas, both extensively produced in Kansas, are of a more uncertain nature, this being particularly true of the gas supply, which is indeterminable in quantity with any great degree of accuracy; also the seasonable demand for domestic use takes preference over the requirements for power purposes, thus requiring that whenever gas is used as a fuel, either oil or some other substitute must be provided.

It cannot be disputed, of course, that on a strict B. t. u. basis both oil and gas have a great advantage over Kansas coal. Until recently, the same unfavorable comparison could be made with regard to the combustion practice of the various fuels. Increased interest and research, however, have placed that coal in a new light. In fact, the engineers of the Kansas Gas & Electric Co. have justified their position by erecting a stoker-fired central station at Neosho, near Parsons, Kan. Its location is in the southeastern corner of the state, where is available, by a short haul, the coals of the Kansas and Oklahoma fields. The coal now being used is known as Cherokee slack, the proximate analysis of which is as follows:

	As Received	Dry
Moisture, per cent	11.2	...
Ash, per cent	15.0	16.9
Volatile matter, per cent	28.3	31.9
Fixed carbon, per cent	45.5	51.2
Sulphur, per cent	4.24	4.77
B.t.u.	10,976	12,360

This coal does not give a great amount of trouble from spontaneous combustion when in storage. When a fire does start, however, the usual procedure is to dig out the heated section and spread it to one side, which proves effective in cooling it off and thus arresting further combustion.

Records of operation at the Neosho plant during the month of March, 1925, show that the following results have been obtained:

Total energy generated	7,621,000 kw. hr.
Station load factor	75.5 per cent
Boiler rating	5.8 lb. evaporation per hr. per sq. ft. of heating surface.
Boiler header pressure (about)	330 lb. ga.
Pressure at throttle (about)	325 lb. ga.
Temp. of water going to the water back	241 deg. F.
Actual evaporation	7.60 lb.
Boiler efficiency	78.5 per cent
B.t.u. per kw. output	17,950
Lb. coal per kw. hr. output	1.625
Steam per kw. hr. output	12.36 lb.

Coal is delivered to the plant by rail, usually in hopper bottom cars. At times coal is delivered in ordinary flat bottom gondola cars. It has thus been necessary to provide a gantry crane at the track hoppers. This crane is provided with a bucket which is effectively used to unload all cars which are not of the drop bottom or hopper bottom types. Coal may be stored either by means of a locomotive crane or by a Beaumont drag scraper and reclamation of the coal is by the same means. This scraper terminates at the track hoppers. The coal is moved up to gates which, when opened, allow coal to be chuted to the hoppers below, which are equipped with automatic loaders that load the balanced skip hoist buckets at the rate of 100 t. per hr.

The skip hoists unload into an overhead bunker at one end of the boiler room. The coal is then chuted to either one of two crushers and then drops into a bunker from which the weigh larry takes its loads. The weigh larry distributes coal to the extended stoker hoppers. Figure 6 shows the weigh larry in position to fill one of the stoker hoppers. In Fig. 7 are shown the motor drives and the feeders for the two crushers. The yard crane, made by the Industrial Works, carries a 1½-yd. bucket. The weigh larry can carry a load of 7½ t. and the bunker capacity is 1000 t. Each crusher is rated at 75 t. per hr. The coal bunkers are made of steel painted with Hermastic.

Electrically Operated Ash Car Used

Each furnace is equipped with two ash hoppers which are constructed of cast iron plates lined with brick. The ash gates are of the horizontal type and are operated by means of air cylinders. These gates were made by the Baker-Dunbar Co. An industrial track extends the full length of the basement floor and on it operates an electrically driven ash car which has a capacity of 100 cu. ft. This car can be spotted under an ash hopper gate, loaded and then moved to a point at the end of the boiler basement, where its contents can be dumped into a chute which loads a separate, single, balanced skip hoist of 100 t. per hr. capacity. This skip hoist unloads into an overhead concrete bunker, from which either trucks or railroad cars can be loaded.

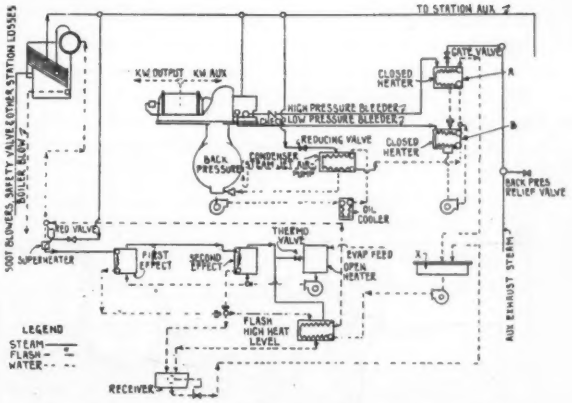


FIG. 1. TURBINE IS BLED TO TWO CLOSED HEATERS

There is a great amount of filled ground to be made and so an ash disposal problem does not exist at this plant, nor will it occur for a number of years to come.

The first unit of this plant called for the installation of three boilers. Those installed are of the Stirling type, made by the Babcock and Wilcox Co. Each contains 12,000 sq. ft. of heating surface, exclusive of the economizer section, which contains 3245 sq. ft. of water heating surface and is built as a unit with the boiler. Each boiler is made up with five drums, three above and two below. The three upper drums are all of the same size and their centers are in the same horizontal plane. The forward

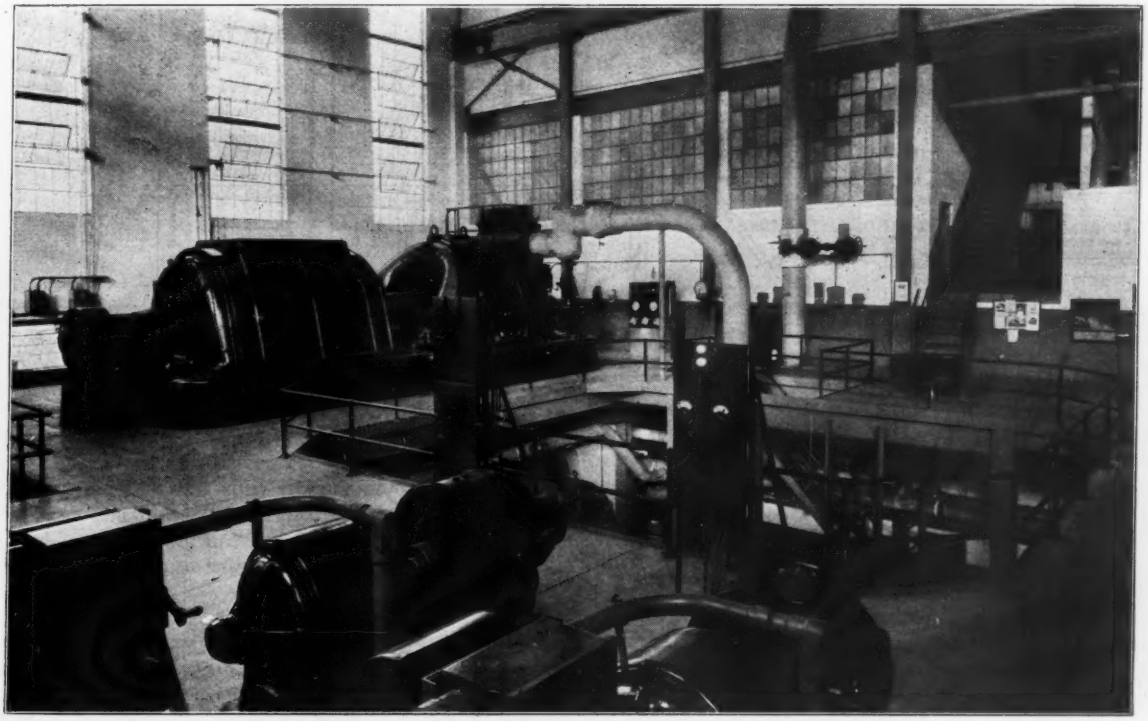


FIG. 2. ONE TURBO-GENERATOR WITH DIRECT CONNECTED EXCITER HAS BEEN INSTALLED

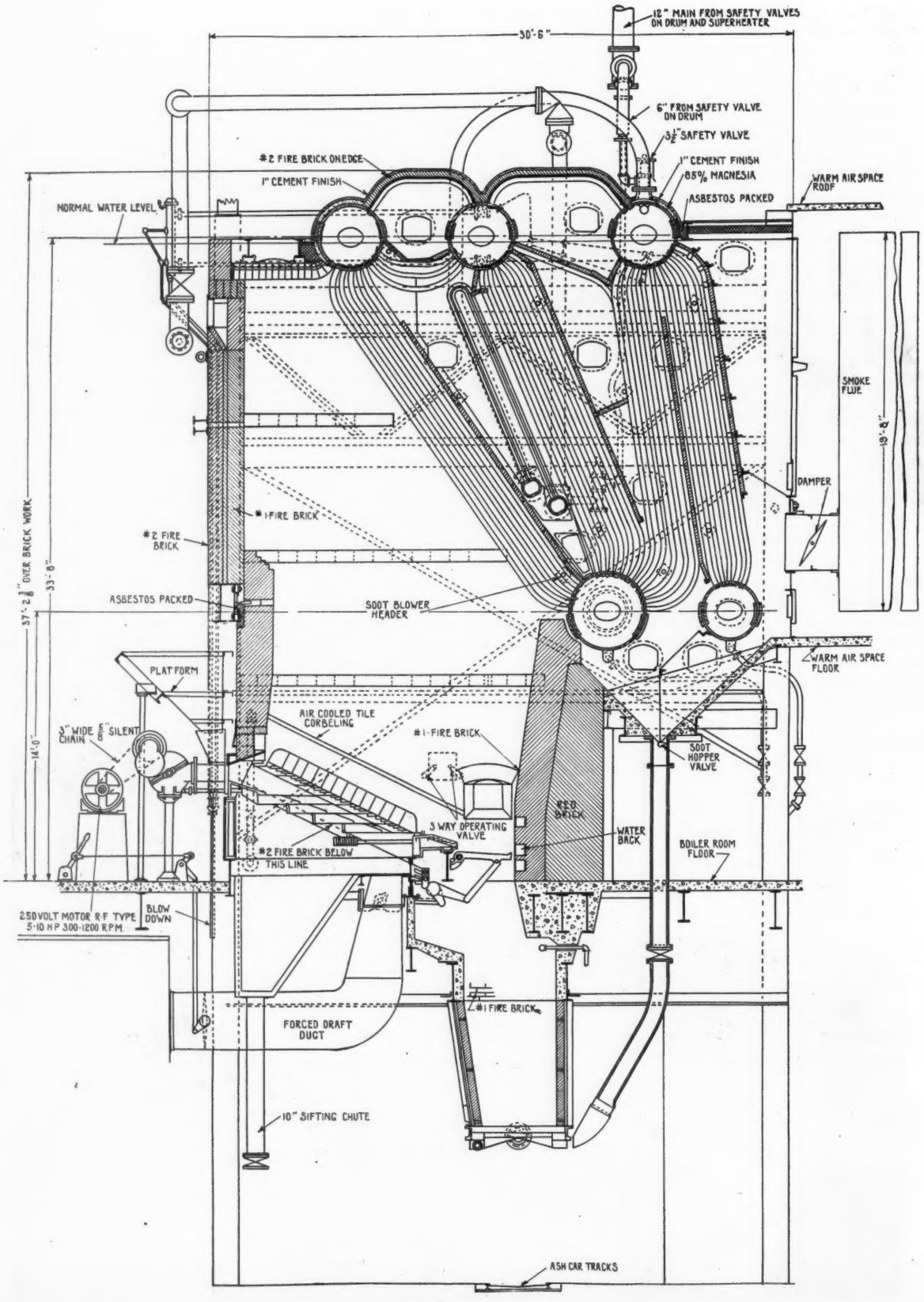


FIG. 3. BOILERS ARE OF THE BENT TUBE TYPE AND ARE FITTED WITH AN ECONOMIZER SECTION

lower drum is the largest of the five and the rear lower drum is the smallest. Five banks of tubes extend from the front lower drum to the front upper drum; six banks extend from the front lower drum to the upper center drum. The front lower drum is also connected to the rear upper drum, from which banks of tubes extend down to the rear lower drum.

No connection is made between the two lower drums, except through the tube banks connecting with the rear upper drum. Steam circulating tubes connect the rear and center upper drums. The center and the front upper drums of the furnace is built up of 9 in. of No. 2 fire brick and 13½ in. of No. 1 fire brick. This wall is supported on two 24-in. I-beams about 9 ft. above the stoker ledge plate. The front wall below that point is from 18 in. to 22½ in. thick and is built up just inside of the wall already referred to. It is supported at its lower edge by the stoker ledge plate. The main part of the front wall is built about 5 ft. in front of the center line of the front upper drum, the furnace being roofed over with a Liptak suspended flat arch. The boiler baffles are arranged for four passes of the gases, the first three passes being parallel with the

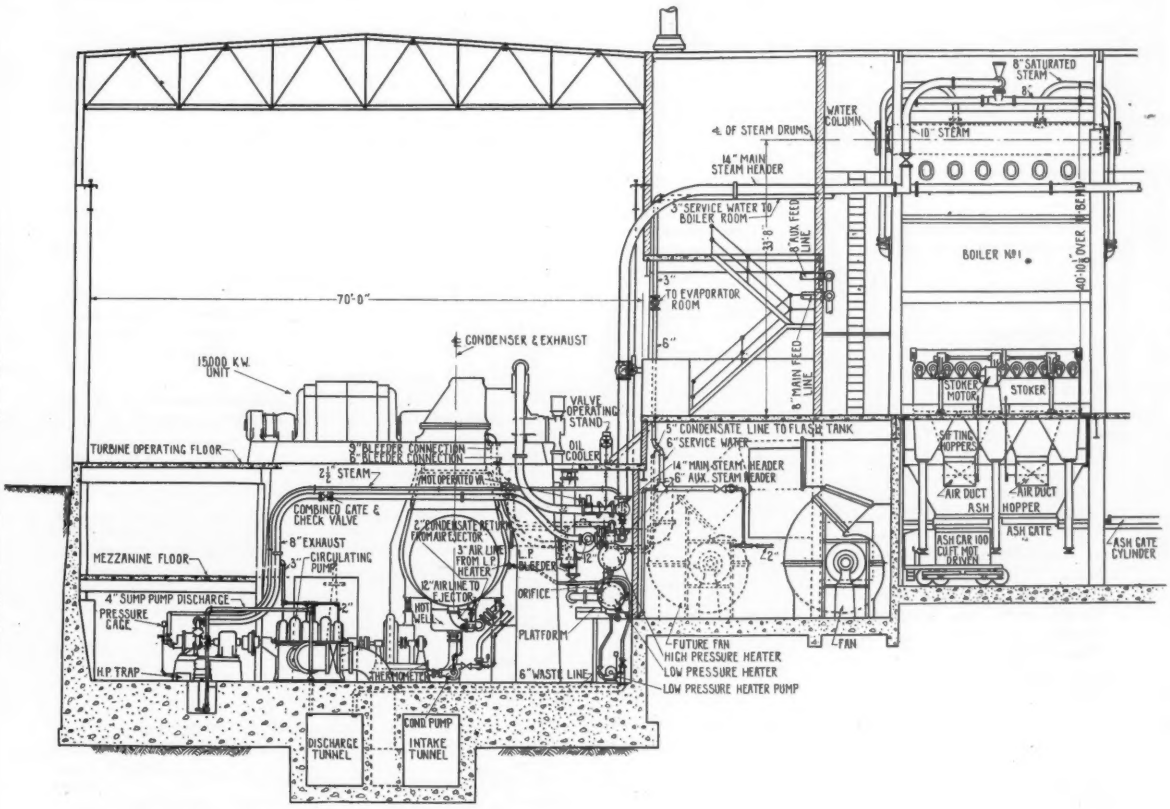


FIG. 4. SURFACE CONDENSER IS ATTACHED RIGIDLY TO THE TURBINE EXHAUST NOZZLE. THREE BOILERS, FIRED BY UNDERFEED STOKERS, SERVE THE ONE TURBINE

are connected by both steam and water circulating tubes. Steam is taken from two points at the top of the rear upper drum, one lead dropping to each side of the boiler to enter the superheater, which contains sufficient surface to provide a 250-deg. F. increase in the temperature of the steam when the boiler is being operated at about 6 lb. per hr. evaporation per sq. ft. of heating surface. The superheaters are of the convection type and are placed between the tubes extending from front bottom drum and the front and center top drums. These boilers were designed for a working pressure of 350 lb. ga. Blowoff connections are made to both of the lower drums.

Boilers Are Set High

The upper drums are set 33 ft. 8 in. above the operating floor. The center line of the gage glass is 4 in. below the center line of the drums, having the water line about 33 ft. 4 in. above the operating floor. The center line of the lower drums is 14 ft. above the floor. The front wall steaming tubes and the last pass being parallel with the tubes of the economizer section. The gases leave the setting just above the rear lower drum.

Air Heated by Breeching

Enclosure of the rear of the setting is made with sheet steel. This wall is protected on the inside by a baffle, which follows the rear bank of tubes, thus forcing the gases to follow the tubes until discharged. Connection to the Connery breeching is short. Above and below the breeching are concrete slabs, which are spaced about 18 in. from the breeching. This leaves an enclosure around the breeching, thus providing a source of warm air. The forced draft fans are connected to this space and are thus able to deliver air to the stokers which has been pre-heated about 50 deg. F. above the temperature of the air in the boiler room.

Beneath the two lower drums is a soot hopper which is connected by means of a pipe so that it can be emptied

Principal Equipment at the Neosho Plant

Boilers—
- Make....Babcock & Wilcox Co.
- Number....3
- Type....Stirling
- Heating surface, sq. ft. each....12,000
- Pressure, lb. ga....350
- Ratio, heating surface to projected grate area....44 to 1

Superheaters—
- Make....Babcock & Wilcox Co.
- Type....Connection
- Superheat, deg. F....250 at 200% rating

Integral Economizers—
- Make....Babcock & Wilcox Co. (Stirling)
- No. installed....3
- Surface sq. ft., each....3245
- Cleaned by....Diamond soot blowers

Stokers—
- Make....American Engineering Co.
- No. per boiler....1
- Type....Underfeed
- Size....12 retort, 29 tuyere
- Projected grate area, sq. ft....272 (dump plate type)
- Projected grate area, sq. ft....305 (clinker grinder type)
- Drive....d.c. motors

Forced Draft Fans—
- Make....Green Fuel Economizer Co.
- No. installed....2
- Type....Double inlet
- Capacity, cu. ft. per min., each....85,000
- Static pres. in. water....6½
- Drive....1 motor, 1 turbine

Stack—
- Erected by....Heine Chimney Co.
- Support....Concrete foundation
- Diameter, ft....13 at top
- Height, ft....355
- Type....concrete

Coal Handling Equipment—
- Make....R. H. Beaumont Co.
- Skip hoist, cap. t. per hr....100
- Weigh larry, cap. t....7½
- Bunker, cap. t....1000
- Drag scraper, t. per hr....80

Locomotive Crane—
- Make....Industrial Wks.
- Capacity, yd....1½

Crushers—
- No. installed....2
- Capacity, each, t. per hr....75

Ash Handling Equipment—
- Make....R. H. Beaumont Co.
- Type....Skip hoist, weigh larry
- Gates, No. per boiler....2
  - Make....Baker, Dunbar Co.
  - Operated by....Air

Boiler Feed Pumps—
- Make....Worthington Pump & Mach. Corp.
- No. installed....2
- Type...1-5 stage, motor driven; 1-4 stage, turbine driven
- Capacity, each, lb. per hr....350,000
- Motor and turbine....General Elec. Co.
- Pressure, lb. ga....400

Evaporators—
- Make....Griscom-Russell Co.
- Type....High pres., double effect
- Capacity, lb. per hr. (normal)....8000

Heaters—
- Make....Ross Heater & Mfg. Co.
- Number....2
- Type....Closed
- Rating, sq. ft. each....850

Main Generating Unit—
- Make....General Electric Co.
- Type....Single cylinder, bleeder, condensing
- Capacity, kw....15,000
- Speed, r.p.m....1800
- Steam temp., deg. F....750
- Steam pres., lb. ga....350
- Generator, voltage....12,000
  - Phase....3
  - Cycles....60
- Air cooler, make....Cooling Tower Co.
  - Rating, cu. ft. per min....50,000

Exciters—
- Make....General Electric Co.
- Number....1 direct connected, 1 motor driven
- Voltage....250

Electrical Equipment—
- Main switchboard....General Electric Co.
- Transformers....General Electric Co.
- Oil circuit breakers....General Electric Co.
- House service board....General Electric Co.

Condenser and Auxiliaries—
- Make....Westinghouse E. & M. Co.
- Type....Surface, 2-pass. 2 sections
- Surface, sq. ft....27,000
- Supported on....Spring base
- Connection to turbine....Rigid
- Circulating pumps, No....1
  - Size, in....36
  - Capacity each lb. per hr....13,000,000
  - Drive....Syn. motor & turbine
- Expansion joints....U. S. Rubber Co.
- Condensate pumps, No....2
  - Capacity, each lb. per hr....220,000
  - Head, ft....130
  - Driven by....Motors
- Air pumps....Jet
  - Inter and after coolers....Yes

House Service Pumps—
- Make....Goulds Mfg. Co.
- No. installed....2
- Type....single stage
- Capacity, lb. per hr, each....250,000
- Drive....G. E. Ind. motors

Miscellaneous Equipment—
- Steam valves....Pittsburgh Valve, Foundry & Construction Co.
- Stop and check valves....Edward Valve & Mfg. Co.
- Blowoff valves....Edward Valve & Mfg. Co.
- Safety valves....Crane Co.
- Atmospheric relief valves....Atwood & Morrill Co.
- Screens....Stationary
- Air compressor....Worthington Pump & Mach. Corp.
- Electric Cranes....Whiting Corp.
- Soot blowers....Diamond Power Specialty Corp.
- Oil filter....S. F. Bowser & Co., Inc.
- Water backs....Babcock & Wilcox Co.
- Pressure regulators....S-C Regulator Mfg. Co.
- Feed water regulators....Northern Equipment Co.

into the basement. Siftings hoppers are also provided under each stoker. They are connected to 10-in. chutes which deliver the siftings to the basement.

Flue gas from the three boilers discharges into a common breeching, extending the full length of the boiler room and discharging into a reinforced concrete chimney. This chimney is 13 ft. in diameter at the top and is 355 ft. high above grade.

Each boiler is fired by means of a Taylor underfeed stoker. Two boilers are equipped with the dump plate type, the projected grate area of each being about 272 sq. ft., giving a ratio of heating surface to projected grate area of 44 to 1. The third boiler is equipped with the clinker grinder type, projected grate area being about 305 sq. ft. and giving a ratio of heating surface to projected grate area of 40 to 1. Each stoker is 12 retorts

wide and 29 tuyeres deep. Power for each stoker is furnished through a Link-Belt Co. silent chain by a d.c., 250-v., 5 to 10-hp., 300 to 1200-r.p.m., General Electric Co. motor. Each motor is mounted on a concrete pedestal placed near the center and in front of the stoker. The pedestals are about 3 ft. 8 in. high. The stoker dump plates are power operated. The stokers are under hand control, whereas the uptake dampers are controlled by The Engineer Co. balanced draft equipment and the air blast duct dampers are controlled by Hagan equipment.

One Fan Is Driven by Motor and the Other by Turbine

Forced draft equipment consists of two fans made by the Green Fuel Economizer Co. These are of the double inlet type, each being rated at 85,000 cu. ft. per min. with air at a temperature of 130 deg. F. Static pressure developed is 6½ in. of water. One fan is driven by a variable speed, a.c. motor and the other is driven by a steam turbine, both drives having been made by the General Electric Co. Starting and stopping of the motor-driven fan is controlled from the basement. Manual control of speed changes of the fans is provided on the operating floor. These fans are located, as shown in Fig. 4, on an intermediate floor between the levels of the boiler room basement floor and the condenser room floor. The air ducts were made by Connery Co.

Make-up water first enters an open heater which is supplied with steam or vapor through a thermostatic control valve from the second effect evaporator. A pump removes the water from the heater and forces it to either the first or second effect evaporator. Live steam is reduced in pressure, passed though a desuperheater and then enters the heating coils of the first effect. The condensed steam drains off to a receiver. The vapor from the first effect passes over to the heating coils of the second effect and the condensed vapor drains off to the receiver previously mentioned.

Vapor from the second effect passes to a closed heater and is condensed, the condensate passing on to the receiver. From the receiver, the water is discharged into another storage tank, shown at X in Fig. 1, from which the boiler feed pumps draw water and force it through the closed heater, just mentioned, and onto the boilers. Water for desuperheating is taken from the boiler feed line.

FIG. 6. COAL HANDLING EQUIPMENT IS MOTOR OPERATED

Two bleeder connections are made to the turbine. The high pressure connection goes to the closed heater A, the condensate draining to closed heater B. Another steam connection is made to heater A from the auxiliary exhaust line, which is fitted with an atmospheric relief valve. The low pressure bleeder connection is made to heater B, the condensate being removed by a pump and discharged into the water line between heaters A and B.

Water from the hot well is pumped through an oil cooler, then through the condenser for the steam jet air pump, then through the heaters B and A, and is finally discharged into the tank X, where it is mixed with the make-up water. Condensate from the air pump condenser flows through the hot well, where it is mixed with the condensate from the main condenser.

Make-up water for this station is obtained from either a pond or the Neosho River. It is filtered before going to the open heater and the Reilly evaporators.

As previously described, each boiler is provided with two 8-in. steam nozzles, one of which is connected to each side of the superheater inlet manifold. Two 8-in. leads, one on each side, extend from the discharge manifold of the superheater to a point directly above the boiler, where they join. At this junction point is a valve and a 10-in.

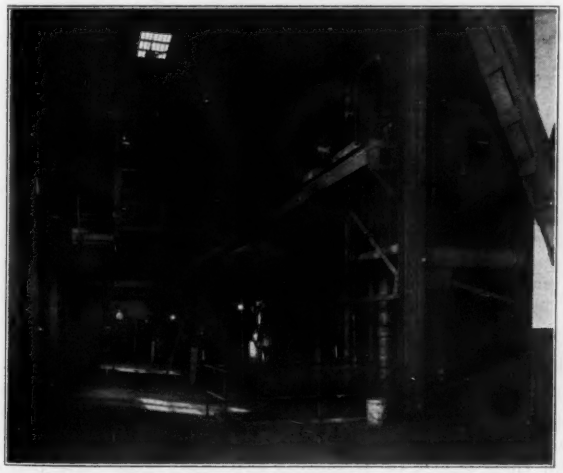


FIG. 5. WEIGH LARRY DISTRIBUTES COAL TO THE STOKER HOPPERS

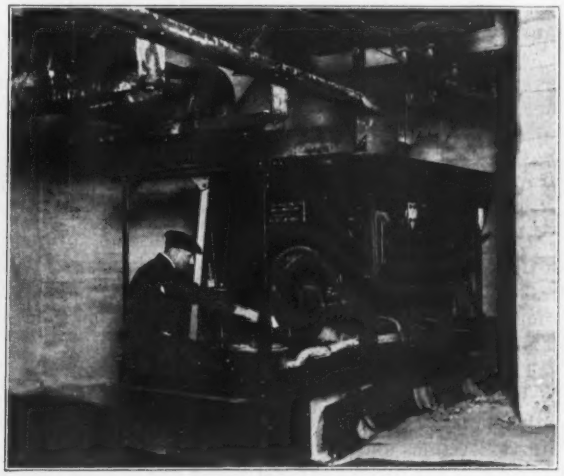


FIG. 7. ASH IS REMOVED IN AN ELECTRICALLY OPERATED CAR

lead, which extends horizontally and then drops down through two long radius bends to a header which extends across the boiler fronts. This header is 10 in. in diameter in front of boilers No. 2 and 3. It then increases to 12 in. and finally to 14 in. at the point where the lead from boiler No. 1 connects in. Opposite boiler No. 3 a 2-in. connection is made and extended to the coal bunker. The 14-in. header extends into the turbine room and then drops down through a long radius bend to a point below the turbine room floor, where the 14-in. turbine lead is taken off. This lead is made up of two long radius bends, thus relieving the turbine steam chest of all pipe-expansion strains. Feed water lines are in duplicate, each being 8 in. in diameter.

Washed Air Is Supplied to the Generator

Space has been provided in the turbine room for two units, although at the present time but one has been installed. It was manufactured by the General Electric Co.

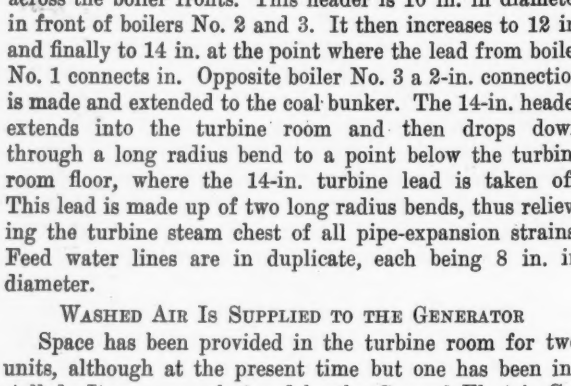


FIG. 8. TRANSFORMER TAPS ARE ARRANGED FOR 12,000, 60,000 AND 132,000 V.

and is rated at 15,000 kw., 1800 r.p.m., 750 deg. F. total temperature of the steam, 350 lb. ga. pressure, 12,000 v., 3 phase and 60 cycle. Washed air is supplied by Cooling Tower Co. equipment at the rate of 50,000 cu. ft. per min. Turbine oil is filtered by the continuous bypass method.

This turbo-generator has mounted on its shaft an exciter. A spare exciter is provided in a 125-kw. motor generator set made by the General Electric Co. This is used either as an exciter, a battery charger or to supply direct current for driving the ash car, the coal larry and the stoker motors, all of which are ordinarily driven by a General Electric Co., 90-kw., m.-g. set. There has also been provided a small m.-g. set for charging the Electric Storage Battery Co. 200-amp. hr. battery, which is used to operate switch gear, lights and motor operated valves.

Two 3-phase, 1000-kv.a., house transformers have been provided. The indoor generator leads and the main circuit breakers are 12,000 v. All other a.c. wiring in the station is for 440 v. The main switchboard and the house board are separate units.

The condenser serving the main turbine was made by the Westinghouse E. & M. Co. It is of the surface type and contains 27,000 sq. ft. of tube surface. It is made up with two sections and is of the two-pass type. It is rigidly connected to the turbine exhaust nozzle and is supported on spring bases. Only one 36-in. Westinghouse circulating pump was installed; this is arranged for dual drive. This pump is rated at 13,000,000 lb. per hr. It is driven from one end by a General Electric Co. turbine and from the opposite end by a 300-hp. synchronous motor, also furnished by the General Electric Co. During present operation, this pump is driven by the turbine, although this was not the intention of the design. This dual drive was provided with the intent to use the motor drive for normal operation, with the turbine as an automatic stand-by. In the event of failure of the electrical auxiliary service, the synchronous motor would then be driven by the turbine as a generator to furnish power for the condensate pumps. This circulating pump is primed by a steam jet.

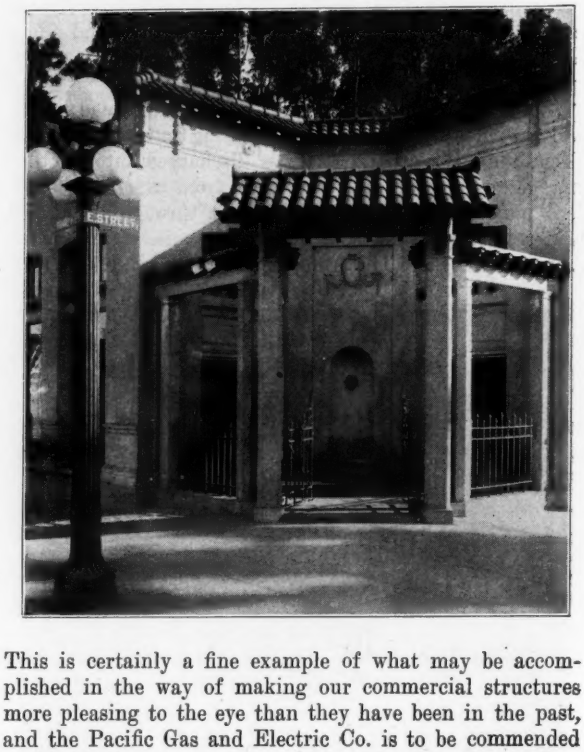
Westinghouse Electric & Mfg. Co. furnished the two-stage, steam-jet air pump and the two motor-driven centrifugal hot well pumps.

As previously stated, current is generated at 12,000 v. The generator leads extend to the outdoor switch yard, where are located two 3-phase, air-cooled, General Electric Co. transformers, rated at 15,000 kv.a. and arranged for 12,000, 60,000 and 132,000 v. taps. Transmission at present is at 60,000 v. to Wichita, Parsons and Pittsburg, Kan. It is expected that the transmission voltage will ultimately be 132,000.

Inter-communication between the various stations of this system is by means of the carrier wave system.

Where Art and Business Mingle

CAN WE mix art with business? We should answer yes and then to back up our statement point to this photograph, which shows a corner of the artistic offices of the Pacific Gas & Electric Co., at San Rafael, California.



This is certainly a fine example of what may be accomplished in the way of making our commercial structures more pleasing to the eye than they have been in the past, and the Pacific Gas and Electric Co. is to be commended for their efforts in promoting this idea. They have introduced the same artistic effects in the design of some of their recent substations.

Growth of Steam Pressure and Economies

Recital of Events That Have Reduced Steam Consumption From 150,000 to 11,000 B.t.u. Per Kw-hr. Generated. By W. R. Herod*

STEAM, as an expansive fluid, has been known for a period comparable to the Christian Era, but its practical application to general power work began in the time of James Watt, who, in the latter part of the eighteenth century, made certain improvements in the previously existing types of engines of Newcomen and others. Watt's most notable contribution was the idea of a separate condenser and this immediately improved the economy of the previously existing types of engines, which were of limited application in the pumping of water from mines, and stimulated development to such an extent that his new engines soon began to be applied for general power purposes, with the steam vessel and locomotive following in due course thereafter.

This development of the steam engine, and its application for general power purposes, enabled larger quantities of power to be massed at given localities than ever before, resulting in the concentration of machines and tools and the institution of our factory system. Accordingly, there resulted what has often been designated as the Industrial Revolution, and the economic significance of the changes brought about is not exaggerated by such a name.

In the early engines of Watt's time and before, however, the pressure of the atmosphere was utilized to do the work, the steam being employed, with the aid of a counterweight, merely to return the pistons to their initial position, after which it was condensed, producing a vacuum, and thereby allowing atmospheric pressure to force the pistons down. The subsequent development in the use of steam has, however, been characterized by a tendency toward progressively higher pressures and temperatures with a resulting betterment in thermal economy.

For a long time, however, the available boilers, which in general were of the shell type, limited the use of pressures to those little higher than atmosphere, though it was known that the double acting steam engine, which had replaced the atmospheric engine, could effectively use somewhat higher pressures. In this connection, it is interesting to note that Watt himself opposed the use of pressures much higher than atmospheric, though it is doubtful if his reasons for so doing were primarily of an engineering nature. Nevertheless, in general, pressures were not raised to much above 40 lb. until about the middle of the nineteenth century.

Better Boilers Permit Higher Pressures

By this time, however, better boilers had been developed which could withstand these higher pressures and, with the introduction of the compound engine to utilize high pressures more effectively, the tendency toward still higher pressures became accelerated as may be seen from the accompanying curve (Fig. 1) which shows this development in a rough pictorial fashion.

For about 30 yr. after the middle of the nineteenth century, the greatest concentrations of steam power were in pumping units but, with the introduction of the electric light and the electric motor for traction purposes, it became economical to concentrate greater power generating developments in a given space, the transmission and distribution of the energy being effected by a few flexible wires. Furthermore, near the end of the nineteenth century, electric wires and motors were rapidly replacing the line shafting and pulleys in manufacturing plants, which further stimulated the concentration of power generating capacity, resulting in the development of larger generating units.

But the thermal economy of these larger steam generating units was also most important and, by this time, with the development of the water tube boiler which began to replace the shell type for most stationary power purposes where large size was necessary, it was appreciated that the use of higher steam pressures, which had originally been introduced to yield greater capacities, likewise tended toward increased economy and reduced fuel consumption. Hence, before the end of the nineteenth century, pressures up to 200 lb. per sq. in. were not unusual for high economy units and higher pressures up to some 1000 and 2000 lb. had been used experimentally many years before.

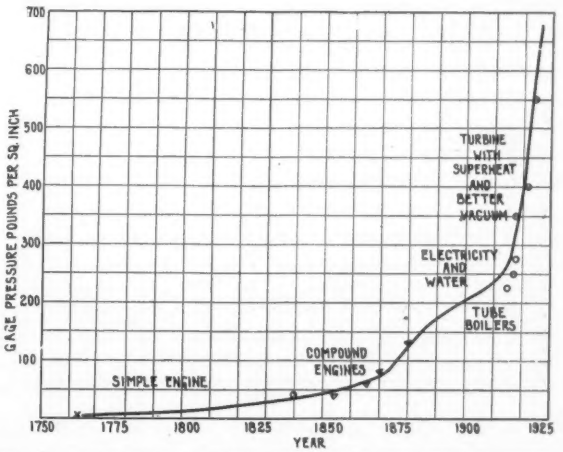


FIG. 1. GROWTH IN STEAM PRESSURES FOR POWER GENERATION

Furthermore, at this period, the fundamental thermodynamic properties of steam became more widely known and we find inter-cylinder extraction heating of the feed water and likewise inter-cylinder reheat of the working steam by means of the high pressure steam advantageously applied in compound engines, especially in connection with high economy pumping engines where the advantages of good load factor justified these measures commercially.

At this time, with the tendency toward concentration of generating capacity economically adopted to the greater use of electric power, searching analyses of the future possibilities of steam engines and other types of prime movers were undertaken with the then long range predictions by Thurston and others that pressures as high as 500 and 600 and even 1000 lb. would be handled, if economic conditions made such desirable.

Shortly after the first of the twentieth century, however, the steam turbine began to be applied to commercial installations and, with its advantages of less space and less cost due to higher speed and with its continuous

*Construction Engineering Dept., General Electric Co.

torque, it practically supplanted the steam engine for large stationary power developments. For the first 15 yr. of the twentieth century, the trend was characterized primarily by the development of central generating stations and by the expansion in size of generating units and in perfection of design, yielding greater economies for practically the same initial steam pressures. There was, however, the general adoption of moderate superheats and the favorable extension of the lower end of the cycle by the improvement in vacuum, which could more economically be utilized by the turbine than by the steam engine.

Hence, up to a period between 1910 and 1915, steam pressures, especially in American power stations, stood little higher than those commercially in use in high grade pumping plants at the end of the nineteenth century but, from this point on, there has been a marked trend toward the higher pressures and higher superheats, in order to take advantage of the increased economy thereby made available and likewise the increased capacity which could thereby be developed with the structural limitations of last stage wheel diameters and exhaust areas. Accordingly,

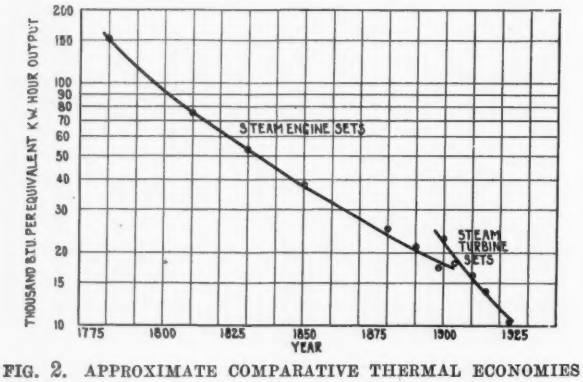


FIG. 2. APPROXIMATE COMPARATIVE THERMAL ECONOMIES OF STEAM PRIME MOVERS REPRESENTING BEST COMMERCIAL PERFORMANCE

we find at the end of the first quarter of the twentieth century, steam pressures of 550 lb. in commercial use with equipment already fabricated and about to be installed for pressures of the order of 1200 lb. and with an experimental installation of the Benson cycle running at pressures up to the critical point of steam at about 3300 lb. per sq. in.

Thermal Economy of Power Generation

Increase in thermal economy from time to time resulting from this development may be seen in Fig. 2, where the B.t.u. consumption of the prime movers per kilowatt hour, or equivalent output, has been indicated from the time of James Watt to the present. The figures up to the beginning of the twentieth century, though originally expressed in different terms, have been taken mainly from Dr. R. H. Thurston's Papers, converted to our present basis of comparison and extended in accordance with more recent steam turbine developments.

Due to the different methods of expressing performance at different times, these converted figures shown in the curve may not be exactly comparative in all cases. They do indicate, however, in a general way the trend of development as expressed in terms of our present standards of overall economy based upon the energy equivalent of the kilowatt-hour as the unit of useful output. It will be noted that the increase in thermal economy for the prime movers has in general been such as may be represented roughly by uniform curves, especially for the development of the steam engine which, at the close of the nineteenth century had attained so favorable an economy in the form of pumping units, many of which are still in use.

With the introduction of the steam turbine, however, enabling larger concentration of generating capacity to be made with more economy of space and material, and in response to the great demand occasioned by the rapid expansion of electric service, scientific development was further stimulated and more favorable economies soon began to be obtained, rapidly reducing the heat consumption per unit of output until, with the recent use of more favorable cycles with higher pressures of about 550 lb. and with extraction heating and reheating the steam, thermal efficiencies exceeding 32 per cent have been obtained from prime movers in commercial stations operating exclusively upon steam.

It is accordingly apparent that the history of the application of steam to power production has been characterized by a progressive tendency toward higher pressures, resulting in a continued reduction in the heat units required to generate a unit of useful work. But already, before the curves have begun to flatten out appreciably, the binary vapor cycle of mercury and steam has demonstrated in commercial service its greater economy in the use of heat and promises to carry the overall efficiency of power generation to far higher values, limited only by the economic availability of suitable materials. Accordingly, the limitations of steam pressures in future times would appear most probably to be governed primarily by considerations of the overall economies, perhaps involving the binary vapor cycle, rather than by the engineering difficulties of carrying steam itself to progressively higher conditions, such difficulties having always in the past been primary influences in the economic balance.

Competitive Examinations will be conducted by the United States Civil Service Commission, Washington, D. C., to secure a hydro-electric engineer, an associate hydro-electric engineer and an assistant hydro-electric engineer to fill vacancies in the Engineer Department at large, Chattanooga, Tenn., at entrance salaries of $3900, $3300, and $2400 to $3000 a year, respectively.

The duties of the engineer are, under the military officer in charge, to be responsible for the complete investigation of a proposed hydro-electric project, from the initial determination of the stream flow through the theoretical design of the plant and the transmission lines, the selection of equipment, to the final estimate of the cost of the complete plant. He will supervise the work of his subordinates, exercise independent engineering judgment and perform related work as required.

The associate and assistant engineers will assist the engineer in his duties as above described, and also perform such work as the preparation of graphs, charts, and maps, the making of computations, the calculation and interpretation of stream flow, load curves, and other relayed tasks.

Competitors will not be required to report for examination at any place, but will be rated on their education, training, experience, and fitness; and writings to be filed with the application. Applications must be received before November 24.

Low Temperature Carbonization in America*

ITEMIZED DISADVANTAGES ARE ADMITTED BUT SOLUTIONS OFFERED THROW BALANCE IN FAVOR OF THE PROCESS. BY H. W. BROOKS**

OPPONENTS of low temperature carbonization base their arguments on the following points:

1. Expansion and shrinkage.
2. Lightness and porosity of coke.
3. Fusion and adherence of coal charge.
4. Accumulation of hard coke.
5. Artificial destruction of coke properties.
6. Failure of materials used in retorts.
7. Losses in quenching.
8. Spontaneous combustion.
9. Difficulty of forming salable fuel in one operation.
10. Heat transfer with refractories troublesome.
11. Cost of operation.

DISADVANTAGES BALANCED BY FAVORABLE POINTS

Expansion and shrinkage are experienced with certain low temperature processes. Coking coals soften, fuse and swell at temperatures in the neighborhood of 660 to 840 deg. F., resulting in internal stresses on the retort walls. At somewhat higher temperatures the plastic mass hardens and at still higher temperatures shrinkage takes place. Most semi-bituminous coking coals give considerable trouble in both high and low temperature processes utilizing stationary unagitated chamber retorts in which the raw coal charge is packed tight. Blending with higher volatile coals must often be resorted to for successful coking.

These difficulties are not experienced with non-coking coals. In neither of the two low temperature processes previously described do these difficulties enter, for in both, the cross sectional areas of the retort are more than ample to provide for expansion.

The period of fusion and of gas evolution in low temperature coking is not so abrupt as in high temperature ovens resulting in the puffing up of the charge and enlargement of the cell spaces. The temperatures which cause subsequent shrinkage to take place in high temperature ovens are seldom attained in low temperature practice. The result is that the semi-coke produced is likely to be light and porous. In the manufacture of briquetted coke for domestic use this is indeed a disadvantage. In the use of coke in pulverized form under power boilers, however, its lightness, friability and porosity are decided advantages. Further, pulverization, if this is necessary, and maintenance costs are decreased. A non-gritty pulverized fuel of high impalpable dust content is producted. This being light and flocculent, lacking in well defined cellular structure and containing considerable volatile matter (usually about 10 per cent), lends itself well to speedy ignition and flame propagation. For this reason only small furnace volumes per unit heat release are required. Its use in the Fuller "Well" furnace will minimize the necessity of further pulverization subsequent to carbonization.

Fusion and adherence of the coal charge does not occur with non-coking coals. Operators, therefore, situated in the Middle West having available such non-coking coals, as those of Illinois, Indiana, Kentucky, or Iowa need give this problem little consideration. It should also be noted in passing that tests of the Bureau of Mines demonstrate that the lower the class of coal the greater the exothermic heat release of the carbonization process, hence proportionately less fuel and operating expenses. The brightest economic possibilities, therefore, for low temperature coking are offered to users of low grade coals in the central stations of the Middle West.

With coking coals, however, the process of carbonization produces a sticky viscous material difficult to handle mechanically and to heat uniformly. Earlier methods experienced considerable difficulty due to the tendency of coking coals to stick on the stirrers and retort walls, as well as in securing proper distribution and uniform flow of hot gases through the retort. That present day designs, however, have completely and satisfactorily overcome this difficulty is best evidenced by the successful demonstration last summer in England for the writer of the processing of an English coal of high coking index in the Fusion rotary retort with absolutely clean walls and stirrers and by a similar demonstration in the United States in a carbocoal retort at Fairmont, W. Va. In carbonization in pulverized form in vertical retorts this difficulty has not been encountered, as the period of fusion is equal, if not more abrupt than in high temperature ovens, due to the relatively speedy heat penetration through the fine coal particles.

With earlier designs of horizontal cylindrical retorts, the coking coals which during the plastic stage adhered to the retort walls, carbonized to a hard coke which interfered with the operation of the agitating devices and seriously affected efficient heat transfer. The two demonstrations cited prove that this difficulty has been overcome in present day designs. In the vertical pulverized coal retorts the difficulty has not been encountered for the same reasons noted in the preceding paragraph. With poorly coking or non-coking coals, fusion does not take place, hence this difficulty is never encountered.

Artificial destruction of coke properties is effected by weathering, slow heating and oxidation of coking coals decreasing their value for the manufacture of high temperature coke. These conditions being inherent to certain processes of low temperature coking are a liability if solid or briquetted domestic fuel is contemplated. They are an asset, however, for systems contemplating the combustion of pulverized semi-coke in boiler furnaces as the destruction of the coking properties for such purposes is to be desired for reasons previously indicated.

CARBORUNDUM AND METALS SATISFACTORY FOR RETORT WALLS

It is contended that the temperatures of low temperature distillation of 750-1100 deg. F. are just too low for satisfactory employment of refractory materials and just too high for satisfactory employment of metals. The more common refractory materials are further rightfully condemned for poor thermal conductivities, liability of leakage and high maintenance costs.

For these reasons they are not employed in pulverized carbonization processes, excepting one in which carborundum is utilized. Iron and steel retorts, however, are employed and it is argued that at these temperatures they are lacking in durability and tensile strength, and are liable to warping, distortion and breakage through absorption of

*The first article of this series, concluded here, appeared in the November 1 issue, page 1087-1091.

**Consulting Engineer, Fuller-Lehigh Co.

carbon. Indeed in Germany some difficulties were encountered in rotary retorts from warping of steel shells. The subsequent successful operation of these German rotaries as well as of the Fusion rotaries in England and Esthonia, and the Carbocoal rotary at Fairmont, W. Va., tends to indicate that these earlier problems have now been successfully solved.

It may be shown that available metals are successfully standing up under conditions quite as severe by inquiry into other industries. Cast-iron retorts have for years been successfully employed in Scottish shale oil distillation at temperatures in excess of those required for coal. The use of the same material for coal carbonization at H. M. Fuel Research Station at London has not yet developed operating difficulties. The cast-iron bells in vertical cement clinker coolers give satisfactory service at temperatures far in excess of those used in low temperature carbonizing. Mild steel retorts under heat more or less continuously for 18 mo. at H. M. Fuel Research Station at London in which the temperature was controlled not to exceed 1100 deg. F., showed no trace of scaling or corrosion and the retort appeared to be in exactly the same condition as when it was first installed.

Other retorts in similar use 3 yr. do not appear to have suffered in the slightest degree. Though the above would indicate no immediate need for further developments of retort materials where the temperatures are properly controlled, there are today available within reasonable price range numerous steel and cast-iron alloys which maintain excellent rigidity up to 1380 deg. F., several of these being guaranteed for still more severe conditions. The use of carborundum retorts would appear to combine the advantages of high heat transfer with the ability to withstand much higher temperatures.

Considerable heat is lost in quenching in all distillation processes producing coke for domestic or metallurgical purposes. Low temperature coke being light and porous is often difficult to cool economically without producing a material of excessive moisture. But when the coke is being burned as fast as produced, not only does this difficulty automatically disappear, but the heat content of the hot coke here conserved becomes a valuable asset (like preheated air from air preheaters) not only in increasing efficiency and speed of combustion but in decreasing combustion volumes. If, for any reason, cooling of a portion of the semi-coke (for example to be sold as domestic fuel) should become desirable, it may be effectively accomplished by allowing it to cool in a water jacketed gas tight heat interchanger, the resultant steam being utilized, or by the Sulzer or Collin processes, cooling with gases.

It is argued that the light spongy low temperature coke is prone to spontaneous combustion and dangerous to store unless well quenched with water. This seems reasonable if carbonized in solid form for domestic service in view of its being more easily ignitible and freer burning than high temperature coke. But when utilizing the semi-coke in pulverized form under power boilers as fast as made, there is no more need of storage than in the direct fired or "unit" pulverizer system. In fact, in base load power plants it would seem logical that the coal feeder system should be designed in much the same manner, regulating the furnace feed of semi-coke from the raw coal end.

It is admitted that there is some difficulty of forming salable fuel in one operation and that separate briquetting is expensive. Though some solid coke suitable for domestic use may be formed if desired in the horizontal cylindrical retorts previously described, the best possibilities for production of domestic fuels seem to lie in unagitated chamber retorts in which all the previously mentioned problems appear. But carbonization by the methods suggested at power plants provides a steady market for the semi-coke breeze and this fuel in pulverized form, ready for combustion, is so desirable that plant operators pay from 40 to 55c per ton (fixed charges included) to get it in that form, in order to save 10 to 25 per cent in fuel cost over any other known means of utilization.

Heat Transfer Solved by Carborundum or Metal Walls

With the lower thermal head necessary, the problem of rapid conduction of heat, if refractory walls are used, becomes somewhat more difficult than with high temperature processes. But where the coal is finely divided and constantly agitated in thin layers in direct contact with heated metal walls, the mixing mechanism constantly displaces the carbonized layer with fresh material, thus materially shortening the carbonization period since the coal can be turned over and brought to the heating walls much faster than heat can be made to flow through layers of material already carbonized. The thermal conductivity of thin metal or carborundum walls is many times greater than that of thick common refractory walls. As a result, much higher throughputs per unit of ground space and far shorter coking periods than are possible in high temperature ovens are obtained. This has been repeatedly demonstrated by commercial scale operating processes.

When considering power and maintenance costs of processes in which coal is prepulverized or stirred in contact with heated surfaces, it is generally admitted (in the words of the Pennsylvania Giant Power Survey Board) that "the most efficient known method of generating power in large quantities is by the use of powdered fuel under steam boilers." This being the case the cost of coal drying, of power for pulverizing (which is little if any greater than that required during or prior to carbonization) as well as most of the necessary maintenance is inherent to the process of most efficient power production. Excess power and heat required for drying and carbonizing over that necessary for pulverized fuel preparation would be almost negligible.

Economics of Low and High Temperature Carbonization Compared

No matter how technically feasible a process may be, the final measure of its service to society must necessarily lie in its dividend paying possibilities. Without being convinced of them, the financier or banker will quite properly never supply the vitalizing force—money—which allows the process to see the light of day on a commercial basis. Consideration of these necessarily involves a careful study of the costs of raw materials and of manufacturing, the character and quantity of the yields of the products to be manufactured and the market prices obtainable for them.

In order to treat of these economic phases with utmost conservatism, both as to comparison of high and low temperature process costs, as well as to the actual profits to be derived from whatever method proves most promising financially, it is proposed to accept as a basis for discussion a formula developed by an opponent of low temperature carbonization, F. W. Sperr, Jr., chief chemist of the Koppers Company. In an article called "Practical Coal Carbonization," appearing in the June, 1924 issue of Me-

chanical Engineering, he sums up his arguments by stating that low temperature carbonization must overcome a handicap of from $0.75 to $1.35 per ton of coal (depending upon prices of tar and gas) to compete with the high temperature process exploited by his company. He does, however, qualify his conclusion by stating that "in the application to power production some of the difficulties of low temperature carbonization disappear," and that "it might be possible to employ the semi-coke in pulverized form, though comparative costs and efficiencies in this connection have not been thoroughly worked out."

Mr. Sperr gives as the comparative yields from the by-product coke oven and low temperature processes the following:

	By-product Coke Ovens	Low temperature carbonization
Gas (550 B.t.u. equivalent) cu. ft.	11,500	6,000
Tar, gal.	12	20
Motor fuel, gal.	2.6	2.6
Ammonium sulphate, lb.	25	10
Coke, per cent	58	66

For these he assumes the following prices:

	By-product Coke Ovens	Low temperature carbonization
Gas at 30c per 1000 cu. ft.	$3.45	$1.80
Tar at 5c per gal.	.60	1.00
Motor fuel at 20c per gal.	.52	.52
Ammonium sulphate at 3c per lb.	.75	.30
Total solids	$1.87	$1.82
	$5.32	$3.62

Formulas Developed for Study of Economics

From these data he deduces the formula for high temperature operation as

$$0.58\,X + 11.5\,G + 1.87 = F + C$$

and for low temperature operation as

$$0.66\,X + 6G + 1.82 = F + C$$

where

C = price of coal in dollars per net ton

G = price of gas in dollars per 1000 cu. ft.

X = price of coke in dollars per net ton

F = sum of operating charges, fixed charges and profit.

The figure of $1.35, which he deduces in favor of the high temperature process, is obtained by solving the formulas on the basis of equal fixed and operating charges and profits F, equal coal costs at $5.00 per net ton C, and equal gas selling prices of 30c per 1000 cu. ft., G. It should be noted in passing that the application of these figures to the high temperature formula shows the figure F of operating and fixed charges plus profits to be $3.25 when coke sells for the same price per ton as the original raw coal. There are several facts, however, some of which are particularly applicable when the low temperature coke is subsequently burned in pulverized form in power plants, which this formula fails to take into account.

First, let us consider oil prices. It has been shown that low temperature tars are thin and light, having a consistency much more resembling oils and that they contain more phenols (tar acids), more neutral oils (napthalene and paraffins) than high temperature tar. The neutral hydrocarbons are quite similar to ordinary kerosene. Having a higher percentage of low boiling constituents and probably a lower percentage of soft light pitch containing much less free carbon and of lower melting point, it lends itself to the production of creosote oil, lubricating oil and greases.

Though not considering tar cracking in this discussion, it is of interest to note that the crude low temperature tar from one ton of coal will refine to produce about 5.5 gal. of tar acids containing much creosol, 1.7 gal. (additional) motor gasoline, 8 gal. of neutral oil and 12 gal. of pitch. High temperature tar, on the other hand, being the product of secondary decomposition produces a dense viscous tar high in free carbon and the aromatic hydrocarbons such as napthalene and anthracene.

Now, it is quite proper in comparing the two carbonization processes with respect to their primary products, as has been done both by Mr. Speer and the writer, that the economics of tar distillation plants should not be entered into. Certainly, however, when the one of the primary products is obviously and fundamentally more valuable in one process than in another, due credit must be given. It is well recognized that the imminent decline in the supply of petroleum will create an intensified demand for the petroleum-like oils of low temperature carbonization. It is a fact that one producer here in America is today selling his low temperature tars at 7c and another at 6c in a yet undeveloped market and it would seem probable that, due to the greater content of constituents so valuable for wood preservation and chemical manufacture, the value of these tars should further increase.

In England, Lander estimates the value of these tars at 10c per gal., while Brownlie estimates them at 9c. Under the circumstances, it certainly would be conservative to figure low temperature tar oil prices at 7c, which is now actually being obtained in America for them.

Compared with Sperr's total oil and motor spirit yield of 22.6 gal. (20 gal. tar, plus 2.6 gal. motor spirit), the carbocoal process has averaged 28 gal., while the fusion process with British coals and an exceptionally low temperature of carbonization has averaged 4.8 to 6 gal. of motor spirit in the tar (3.6 to 6 gal. stripped from the gas) plus 12 to 24 gal. of dry paraffinoid oils. Thus, though there is every reason to believe both the motor spirit and total oil yields higher than shown in the formula, the original figure of 22.6 gal. will be accepted in order to be ultra-conservative.

Coke yield for the low temperature process is undoubtedly low at 66 per cent unless this is the estimate of net yield after the coke necessary for the producer that heats the retorts has been deducted. In this latter case the operating charges later estimated in this paper as chargeable against low temperature carbonization will be too high to the extent of the value of 4 to 9 per cent of the total coke values. The carbocoal and fusion processes both obtain 75 per cent coke yield, and this apparently represents a fair average as found in a number of European plants visited by the writer last summer.

It seems highly probable that the price obtainable for the high calorific value (800 to 1000 B.t.u.), low temperature gas which is so valuable and desirable for enrichment of leaner gases from water gas producers or high temperature coke ovens should be higher per therm than relatively lean high temperature gas. Inherent advantages of gas as a fuel for heating, both domestic and industrial, together with rapidly failing sources of natural gas, are creating an intensified demand for gas obtained from coal. Manufacturers of enriched blue water gas are today paying approximately 20c per 1000 cu. ft. to enrich 300 B.t.u. water gas to 520 B.t.u. No reason is immediately apparent why they

should not gladly pay 40c per 1000 cu. ft. for low temperature gas which would accomplish an equivalent enrichment with marked savings over present costs. Having no definite proofs available, however, that such prices have been obtained, the continuance of a conservative viewpoint demands the acceptance of the equivalent gas prices of the formula.

Installation Costs Lower Than High Temperature Process

The prevailing installation cost estimates on large plants of practically all low temperature carbonizing processes of the types recommended herein are about $600.00 per ton of daily capacity. They range as high as $1000 per ton-day on small plants of say 250 T. daily capacity. These figures have been checked by the writer with the cost data of a large manufacturer when building and installing equipment of similar character and found to be ample to cover all labor, materials, overhead, reasonable royalties and an ample margin of profit. Known investment costs for standard by-product coke ovens range from $1800 to $2400 per T. Certainly, therefore, the fixed charges on the investment for low temperature ovens should not be equal as suggested by Sperr but should be considerably less than half those of the high temperature method. As plants of fairly large size are contemplated in this discussion, the conservative figure of $800 investment per ton of daily capacity will, therefore, be employed in subsequent calculations of fixed charges.

Not only were the fixed charges assumed the same to produce the results unfavorable to low temperature methods, but also the operating expense. This latter comparison is equally untenable, for it the heat used for carbonization plus subsequent condensation of distilled products is anywhere near the relative carbonizing temperatures (1700 deg. to 2000 deg. F. as compared to 1300 deg. F.) as one would logically expect, the fuel requirements would be lessened approximately in the ratio of 100 per cent less 1100 ÷ 1850 or nearly 40 per cent. This takes no account of the obviously greater efficiency of heat transfer through metal or carborundum walls to constantly agitated, thin layers of coal as compared to that through the refractory walls of coke ovens to the thick unagitated coal charge within, nor of the greater combustion efficiencies obtainable with the larger furnace volumes economically feasible in low temperature processes. Furthermore, the latter being continuous in operation and of high throughput, labor charges are considerably less. In England, by the fusion process, total operating expense, including maintenance has been found to be about 60c, while here in America by the carbocoal process they have been shown to be about 70c per ton of coal carbonized. In order to be ultra-conservative, however, in subsequent calculations, a figure of $1.00 per ton will be employed.

Mr. Sperr estimates boiler efficiency in a stoker fired power plant burning 1060 T. of combined high temperature coke and breeze at 78 per cent. Though the writer has never seen tests demonstrating such efficiencies under these conditions, it is conceivable that they might be possible with superheaters, economizers and air preheaters. Under similar conditions, pulverized fuel has shown efficiencies as high as 90 per cent. With the methods proposed, therefore, pulverized low temperature coke would enjoy an inherent advantage in the ratio of 90 to 78, or 1.15 times greater than high temperature coke burned on stokers. Furthermore, in steamed retorts, Fieldner states that "the steam undoubtedly activates the carbon to a certain extent—due to the steam activation (the semi-coke) is easily ignited and readily combustible." Again, the pulverized fuel being delivered dry, hot, and in finely divided state, would have chargeable against it no dryer and little, if any, of the pulverizing expense which would ordinarily be chargeable against pulverized fuel operation.

Summing up, therefore, it may be conservatively estimated that the methods proposed deliver to the boiler furnaces a fuel beneficiated at least to the extent of 17 per cent over high temperature coke burned on stokers due to greater inherent economies of the process to which it is adapted and the more desirable form in which the fuel is delivered.

Recalculation of Sperr Formula Favors Low Temperature

It will be recalled that in the previous calculation quoted, the exponent of by-product coke ovens assumed the value of his coke to a power plant operator as equivalent to that assumed for raw coal. This is obviously incorrect for high temperature coke mixed with breeze, first, because it is not ordinarily as efficient nor desirable a fuel when burned on chain grate stokers as is raw coal on underfired superstokers and, second, because its heat value is less. The figures quoted assumed 14,000 B.t.u. coal to give 13,200 B.t.u. coke, either for high or low temperature carbonization. Though the results of analyses have generally proved more favorable to coke from the later method, in order to keep the results as parallel as possible, these figures will be accepted for purposes of comparison.

The high temperature formula then becomes

$$0.58 \times 13{,}200 \times 14{,}000 + 11.5\ G + 1.87 = F + C$$

or by transposition and substitution ($5.00 coal and 30c gas) the sum of fixed charges, operating expense and profit F becomes

$$F = [(0.58 \times (13{,}200 \div 14{,}000) \times 5.00) + 11.5 \times 0.30) + 1.81] - 5.00 = (2.73 + 3.45 + 1.87) - 5.00 = \$3.05$$

Now, similarly substituting the new figures of 7c for high temperature oils, a 75 per cent coke yield—17 per cent beneficiated, together with known operating expenses of $1.00 per ton and fixed charges based on a conservative low temperature plant cost of $8.00 per ton daily capacity, the detailed balance sheet for the low temperature process becomes as follows:

Ammonium sulphate, 10 lb. at 3c per lb.	$0.30
Tars, 20 gal. at 7c per gal.	1.40
Motor fuel, 2.6 gal. at 20c per gal.	.52
Gas, equivalent of 6 M. of 550 B.t.u. at 30c per M.	1.80
1500 lb. coke, beneficiated in the ratio $1.17 \times 13{,}200 \div 14{,}000 = 1.10 \times 0.75 \times 5.00$	4.12
Total income per ton	$8.14

Necessary expenditures per ton become as follows:

Investment charges, interest, depreciation and taxes per ton at 20 per cent on $800 investment	$0.44
Operating charges, fuel for heating retorts, power, water, labor, maintenance and supplies	1.00
Miscellaneous and overhead	.10
Coal per ton	5.00
Total cost per ton	6.54
Profit per ton, low temperature process	1.60

Now, refer again to the combined fixed charges, operating expense and profit of $3.05 per ton previously figured for coke oven operation. The application of the same

figure of 20 per cent to cover investment charges, interest, depreciation, taxes, amortization and contingencies on a high temperature coke oven plant costing $2000 per ton day reveals fixed charges alone amounting to $1.10 per ton processed, leaving a total of but $3.05—$1.10 or $1.95 per ton to cover both operating expense and profit for the high temperature process. Profit alone for the low temperature process figures within 35c per ton of the total profit and operating expense of the high temperature method, leaving little doubt but that the former offers far greater money making possibilities for the central station than the latter.

It appears probable, due to the industrial concentrations near the coal producing districts of the United States and the enormous demands for electrical energy in these regions, that at least the first installations of the character proposed will be located where slack or screenings could be purchased much cheaper than $5.00 per ton. In order not to change the B.t.u. figures employed, consider for the moment a prospective plant location in Pennsylvania or West Virginia, at or near a mine mouth, where 14,000 B.t.u. coal would be purchased for say, $2.50 per ton. Then again employing the same formulas, the total fixed charges, operating expense and profit for the coke oven process would be increased to $4.16 per ton from which the same deduction for investment charges of $1.10 would give $3.06 per ton for both operating expense and profit.

On the other hand, the prospective profit alone for the low temperature process would by similar treatment become $4.10 per ton or 34 per cent more than the total operating expense and profit for the coke oven process. Under such conditions the entire fuel for power could be delivered into the boiler furnaces as of no value and the carbonization process would still show a reasonable margin or profit.

Disadvantages—technical and economic—of low temperature carbonization, ascribed by its opponents, largely or entirely disappear when the recommended methods are subjected to analytical consideration.

Causes of Condenser Tube Failures

Mechanical and Chemical Actions, the Latter Due in Part to the Crystal Arrangement of the Metals Employed, May Cause Tube to Fail

IN ANY ATTEMPT to study the factors affecting the life of condenser tubes, the data obtained from practical experience in condenser operation are of more value than theoretical considerations. Operating conditions and the quality of circulating water are different for each plant and an intelligent study of condenser tube troubles in one plant might not be at all applicable to another. Under certain conditions a perfect tube may fail. The following discussion may assist the engineer in any investigation of tube failure he may wish to make. The causes of tube failure are discussed briefly and some data are given on the mixtures commonly used for condenser tubing.

When an investigation of tube failure is desired, full information must be obtained. Some of the important points to be determined, according to the Wheeler News, published by Wheeler Condenser and Engineering Co., are as follows: (1) the source of cooling water, whether fresh, salt or brackish, containing acid or organic matter and whether cooling towers or spray ponds are used; (2) the mechanical analysis of the water, amount and kind of suspended matter; (3) whether the tubes are choked with solid matter and nature of same; (4) the velocity of the water through the tubes; (5) the arrangement of baffles and the steam distribution; (6) whether tubes were packed properly.

If a failed tube is removed from a condenser for inspection the following points should be noted: (1) the top and bottom as in service; (2) the direction of water flow; (3) the position of sample piece in length of tube and whether near support or tube plates; (4) the overall length of tube; (5) the length of service of corroded tube; (6) position of tube in condenser, also whether corrosion has been evident in other parts of condenser; (7) if plant has other condenser units, whether corrosion appears in one only, or in all of them; (8) if tube failures are more prevalent at certain seasons of the year.

Both ends of the sample should be plugged, as an inspection of the scale or deposit may give some clue to the cause of corrosion.

A few words regarding the ways in which condenser tubes fail may be of interest. Season cracking results from improper annealing, whereby internal strains are not removed. Season cracking can be entirely avoided by proper manufacture.

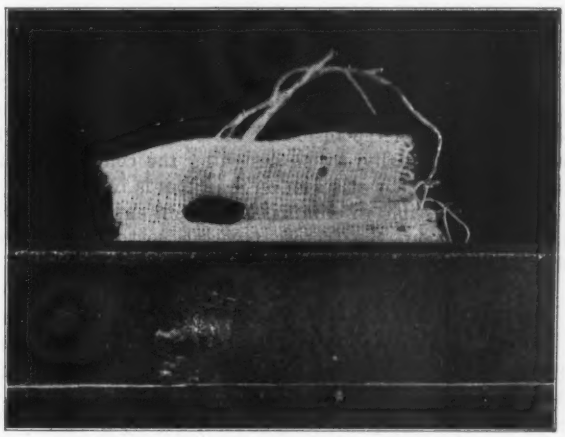


FIG. 1. AFTER 12 YR. OF SERVICE THIS LEADED ADMIRALTY TUBE FAILED WHEN THE SLUG OF IRON SHOWN BESIDE IT LODGED IN THE SCALE AND SET UP LOCAL CORROSION

Complete corrosion occurs as a gradual general thinning, sometimes accompanied by slight dezincification (removal of zinc). It often occurs at the inlet ends of the tube if there is an opportunity for the accumulation of gases at that point. Necking of the tube through crushing when the tubes are packed will cause the formation of a gas pocket.

Generally speaking, complete corrosion is caused by a highly acid water. If a condenser is operated with a cooling tower, the tower acts as a salt concentrator, gradually building up the percentage of salts per gallon and, depending upon the character of these salts, greatly increasing the corrosive action. Complete corrosion can be reduced materially by selection of the proper mixture, proper temper of

tube, attention to the quality of circulating water, and care in packing.

Dezincification consists for all practical purposes in the removal of zinc, leaving the copper behind in a mossy, brittle condition. The vibration of the condenser often causes this brittle material to crack. This action takes place at a higher rate in certain alloys than in others. It is increased by high water temperatures. It can be materially reduced by selection of the proper mixture. In Fig. 2 is shown a Muntz metal tube taken from a condenser using sea water for circulating water, the tube having been in service two years.

Deposits of foreign particles carried by the circulating water may cause a local cell action or pitting at the point of deposit, as shown in Fig. 1. Excessive local heating, such as would result from steam directly impinging on the tubes, also causes local action resulting in pitting. In this

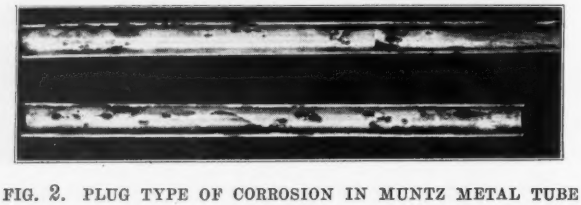


FIG. 2. PLUG TYPE OF CORROSION IN MUNTZ METAL TUBE OCCURRED AFTER 2 YR. OF SERVICE, USING SEA WATER. THIS SHOWS THE RESULT OF USING THE WRONG ALLOY FOR A GIVEN SERVICE

case, the action is assisted by a certain amount of erosion. Pitting can be reduced by maintaining a water velocity through the tubes sufficient to keep the inside surface swept clean at all times, by careful manufacture so that no slivers are left in the inside of the tube to catch foreign particles and, finally, by so designing the condenser that direct impingement of steam on the tubes is impossible.

It is impossible to eliminate corrosion entirely, but, to a certain extent, the factors favoring corrosion may be diminished.

Mixtures Commonly Used for Condenser Tubing

Principal commercial brass mixtures used for condenser tubes are: (a) pure copper; (b) copper 70 per cent, zinc 30 per cent; (c) copper 67 per cent, zinc 33 per cent; (d) copper 70 per cent, zinc 29 per cent, tin 1 per cent (Admiralty metal); (e) copper 60 per cent, zinc 40 per cent (Muntz metal).

All of the brass mixtures look alike to the naked eye and it is only when we begin to investigate with a microscope that we find differences. Figure 3 shows the micro structure of both Muntz metal and Admiralty metal. In the case of the latter, the illustrations show the structure of the cast metal and the entirely different arrangement of crystals in the finished tube, after the annealing and drawing operations.

In a similar manner to alcohol and water, copper and zinc are soluble one in the other in all proportions but, on solidifying, they form a number of entirely distinct solid solutions or phases differing in proportions of zinc to copper. We then have a high copper content phase called alpha and a high zinc content phase called beta. The alpha phase is straw colored, while the beta phase is a brilliant yellow. Down to about 66 per cent copper, we have a crystalline structure, composed entirely of grains of alpha. Below this percentage we begin to find the alpha grain surrounded by grains of beta.

It is to be noted, therefore, that Muntz metal brass is composed of alpha plus beta, while the other mixtures are composed of alpha grains alone. In the case of Admiralty brass, we have alpha grains in which a small percentage of tin is dissolved. The addition of tin to alpha considerably increases the resistance to corrosion. Alpha brass has different physical properties than beta. It is more ductile when cold, but cannot be worked hot. Beta brass, on the other hand, while not so ductile as alpha when cold, can be worked hot. This property of hot working makes the manufacture of Muntz brass much easier.

It happens that the beta phase is not so resistant to corrosion as the alpha phase, with the result that, under bad water conditions, the beta grains are attacked, dezincification starting there and proceeding into the alpha. With clean, fresh water this action is so slow that Muntz tubes are considered perfectly satisfactory.

Admiralty brass has now become standard practice for use in salt water or badly polluted fresh water. Pure copper tubes have been used with success in many instances, but, as the price has been even higher than Admiralty, they have not been in as high favor.

It might be well at this stage to point out an incorrect conception which exists in the minds of some operating engineers. Oftentimes when a Muntz metal tube, improperly used in salt water, is removed from a condenser, the corrosion seems to have left streaks of practically pure copper, and the statement has been made that there was original segregation of copper and zinc in spots. Such a thing is absolutely impossible, since, as stated above, the metals are soluble in one another forming a homogeneous solution (alloy). It would be impossible to manufacture a tube from such a segregated billet, since it would have no elements of structural strength. The copper spots are the result of a continuous corrosive action classified under dezincification.

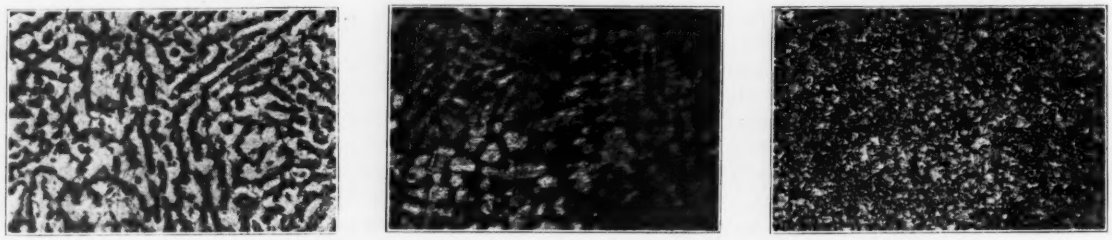


FIG. 3. MICROSCOPE REVEALS CRYSTAL STRUCTURE OF MUNTZ AND ADMIRALTY METALS

Left—Micro structure of cast Muntz metal. Middle—Micro structure of cast Admiralty metal shell, before working. Right—Micro structure of same Admiralty metal, after the cold drawing and annealing processes have been completed to form it into a finished, 1-in., 18-gage, condenser tube. Note the fine uniaxial grain.

Economy Should Govern Power Source

SAVING MOST OFTEN FOUND IN A COMBINATION OF PLANT GENERATION AND PURCHASED POWER. BY M. BUCKLEY

WHEN STUDYING the economics of power generation, many plant owners think they must either generate their own power or purchase it on the outside. As a general rule they do not realize that a co-ordination of the two methods may be the most advantageous. At one time I ran a plant that generated power for a large machine tool works and the young manager, being ambitious to cut costs, investigated the cost of purchased power and found that he could save about $5000 a year by shutting down the boilers and engines. The plant ran three shifts with an operating force of nine men, but with purchased power all of these could be dispensed with in summer, as no steam was required, and in winter three firemen could handle the heating load. We were equipped with five return tubular boilers and an assortment of engines seldom seen in any plant. There were six in all, driving d. c. generators with a total capacity of 860 kw-hr. All were operated non-condensing the year round and about 30 per cent of the exhaust was used for heating in winter, our power demand calling for much more steam than the heating load.

Consulting engineers estimated the water rate of our engines to be 36 lb. per kw-hr. and coal per kw-hr. about 5 lb. The wage rate per hour of the engineer, fireman and helpers each shift totaled $2.92. With coal at $6.00 per T., a load of 600 kw. during the day and 350 kw. at night, the cost per kilowatt-hour was figured to be 2.11 cents for fuel and operating labor alone. The power company stated that taxes, insurance, repairs and supplies would raise the figure to three cents and offered to supply current for 2¼ cents. Although I attempted to prove our power costs less than they assumed by insisting that the engines be credited with the exhaust steam used for heating, that the heating system be charged with 25 to 30 per cent of the winter coal consumption and half the labor cost during the heating period, a contract was signed for one year.

Our cost of generating power apparently was reduced to less than 2½ cents when due allowance was made for the cost of heating, thereby convincing the manager that the plan of buying at 2¼ cents would net the company a saving of $5000 per year, besides $6000 which the engines would bring, if offered for sale. Allowance, however, had to be made for a 600-kw. motor-generator set which it was necessary to purchase, as our plant motors used direct current.

During the summer it seemed that the plan was a success, as we burned no coal, laid off nine men, and sold all the engines except the largest of 200 kw-hr. capacity. To provide warm water for washing, we installed a gas fired heater that required no attention, my services being retained to maintain the electrical equipment. In the fall two boilers were started to heat the plant and three firemen were hired for this duty. Our fuel bill at the start was only one-third of the former amount but in zero weather increased to about one-half. The boilers, operated at 35 lb. pressure, used 10 to 12 T. of coal daily. I connected our generating unit in parallel with the motor-generator set, although our contract would not allow us to generate current as long as there was no interruption in the outside supply, but in case of a fuse blowing outside the plant we were temporarily without power.

COMBINATION OF POWER SOURCES SHOWS ADVANTAGE

Permission was obtained to operate our engine under full load for one hour once a week and one cold day I raised the boiler pressure to 135 lb. and started the engine. After paralleling, I carried 210 kw. for an hour and noted that the load on the boilers did not increase perceptibly. I called the manager into the power plant and explained my experiment. When he saw that we were getting the output of our generating unit at no increase in labor and only a small increase in coal costs, he promised that in the future the plant would always be heated with exhaust steam and the contract with the power company would not be renewed unless permission was given to operate our engine in parallel with the motor-generator set and generate sufficient current to insure an exact balance between steam exhausted from the engine and the requirements of the heating system.

With the power company's meter showing a reduction of over 200 kw. per hr. it was not hard to convince him that a combination of two power sources produced cheaper power than either one had done alone, since a rough calculation showed the saving to be $4.50 ($200 \times 2\frac{1}{4}$) for each hour that the engine operated at full load.

GREATER POWER BY INCREASING ENGINE SPEED

Now that I had won his confidence I submitted plans to reduce our power costs still further. Formerly 15 lb. back pressure had been carried in winter, since satisfactory results were never secured at a lower pressure. Due to insufficient size of heating mains, the pressure drop in the line was so great that in some remote coils the pressure was not over 4 lb. All condensation drained by gravity to the boiler room and was used for our feed water. Larger supply lines to various coils were installed and the system was changed to the vacuum return type, thus permitting a reduction in back pressure to 3 lb. The coil surface was increased and when some of the overhead coils were placed on the wall near the floor, better results were obtained.

The engine operated at 80 r.p.m. and was belted to the generator, so I decided that if the engine was speeded up to 90 r.p.m. the power output would be 25 kw-hr. more, the generator to run at the former speed by using the right pulley ratio. With the increased speed and reduction in back pressure the engine capacity was 25 per cent greater and, as all of the exhaust could be used, this was a great gain during the heating period. We could carry as high as 250 kw-hr. without lifting the atmospheric relief valve, and no difficulty was experienced with the increased load on the generator.

In plants where no process steam is used, there is no doubt that economies may be effected by discarding old equipment and buying power but in winter, in the northern states, where steam must be generated for heating, all power possible should be generated up to the point where there is an excess of exhaust steam. As this plant was in a location that made condensing operation in summer impractical, buying power was quite logical. Of course, in other locations, in summer, there is a possibility of using condensing uniflow engines or other efficient units as a means of securing cheap power and being independent of outside sources. But where no condensing water is available, the plan followed in this plant seems to be the logical solution.

Diesel Engine Costs

INSTALLATION AND OPERATION EXPENSES ARE GATHERED BY A COMMITTEE OF GREAT LAKES DIVISION, N. E. L. A.

IN THE report of the sub-committee on Diesel engines, presented at the recent meeting at French Lick by C. H. Purdy, chairman, is found an interesting collection of data. The report gives comparison between cost of power from Diesel engine plants and central stations and comments particularly on errors in allowance for depreciation, taxes and maintenance which have been discovered in reports, especially from municipally owned and operated plants.

Space does not permit using the entire report, but some of the data are here given.

Since 1922, the price of fuel oil in Chicago has varied from 3.95 cents to 5.4 cents a gallon, usually showing a rise during the first quarter of the year, with a distinct drop during the summer. The average price has shown a yearly increase.

Tabulated cost for a two-unit plant of 2500 brake horsepower is of interest because of the complete detail included.

COST OF 2-UNIT 2500-HP. DIESEL ENGINE PLANT

	Cost	% of Total	$ per B.H.P.
Engines (f. o. b.)	$161,526	50.00	$64.61
Generators (f. o. b.)	15,076	4.66	6.03
Switchboard and Wiring	8,051	2.49	3.22
Piping—Engine Room	10,026	3.10	4.01
Installation	14,701	4.55	5.88
Freight	3,876	1.20	1.55
Misc. Engine Room Equipment	9,176	2.85	3.67
Total Machinery and Equipment	$222,432	68.85%	$88.97
Power House and Foundations	19,107	5.92	7.64
Oil Storage	18,945	5.88	7.58
Cooling Water System	50,826	15.74	20.33
Incidentals	11,614	3.61	4.64
Total Installation	$322,924	100.00%	$129.16

For 31 plants located in Great Britain and possessions, with installed capacity of 22,082 kw. and generator load factor of 59.4 per cent, the fuel oil consumption averaged 0.734 lb. per kw-hr. and lubricating oil 2.27 gal. per thousand kw-hr. With cost of fuel oil at $3.52 per 316 lb. barrel and lubricating oil at $.78 a gal., the engine costs per kw-hr. averaged as follows, the values being in cents: fuel, 0.817; lubricating oil, 0.174; water, 0.014; miscellaneous supplies, 0.028; operator's wages, 0.483; maintenance, 0.343; total, 1.859.

Data taken from the Prime Movers Committee report show, for operation in five Texas Diesel plants, capacities 310 up to 930 kw. and station load factor 75.8 down to 26.8 per cent, a fuel oil consumption of 0.68 lb. per kw-hr. for a large plant with high load factor to 0.955 lb. for medium size plant with low load factor. The fuel oil averaged 19,000 B.t.u. per pound and the B.t.u. per kw-hr. output ranged from 13,000 up to 18,120. Lubricants ran from 0.00093 gal. per kw-hr. up to 0.00212; engine maintenance cost from 0.323 cents to 0.846 cents; fuel cost from 0.381 cents to 0.53 cents; lubricant cost from 0.0429 cents to 0.153 cents; miscellaneous supplies from 0.043 cents to 0.091 cents; total maintenance from 0.337 cents to 0.930 cents; labor, from 0.202 cents to 0.52 cents; total production cost from 1.012 cents to 2.197 cents.

At Grove City, Pa., the municipal plant has three 350-hp. solid injection Diesel engines driving 300-kw. generators. Four months' record as given in Oil Engine Power shows average consumption of 0.097 gal. fuel oil and 0.00125 gal. lubricating oil per kw-hr. With fuel oil at 7.25c a gallon, lubricating oil at 45c, cooling water at 15c per 1000 gal., interest at $393, depreciation at $375 and wages at $525 a month, the average costs per kw-hr. were: for wages, 0.26c; for fuel, 0.66c; for lubricant, 0.05c; for repairs, 0.02c; for water, 0.06c; for depreciation and interest, 0.39c; total per kw-hr., 1.44c.

For another group of stations running from a single 165-hp. engine to 4 500-hp. engines, the cost per kw-hr. ran from 3.15c down to 1.07c, with an average of 1.67c. An interesting point is that the smallest plant showed a cost of 1.22c, considerably below that for most of the larger plants.

Your Health Is Your Responsibility

BY H. L. WILLIAMS

EVERY MAN is partly responsible for the conditions of the place in which he is employed. Granted that the united action of workers brings about the greatest improvements, such action is, after all, created by individual initiative and understanding.

Short hours allow more time for diversion and rest and higher wages make possible better medical care and higher living standards, but neither hours nor wages are in as great need of improvement as the ventilation, lighting, toilet facilities and protection against dust in the workshops.

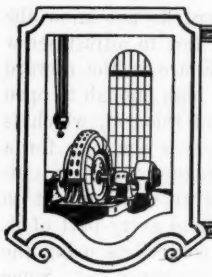
Approximately 54,000 wage-earners died from tuberculosis in this country in 1921 (using the census as a basis). Factors which create this high mortality are those mentioned above, plus fatigue and worry. The prevalence of tuberculosis may be called a sort of key to the health of workers for the conditions fostering it also cause other preventable illnesses. Lack of fresh air, injurious dusts and over-fatigue so lower the general resistance of the body that it is unable to throw off whatever germs may come its way.

Food is the most important item in the worker's health. He should have sufficient time to eat a nourishing lunch, preferably a hot one and to chew it slowly. The best drink at noon is a bottle of milk. Not long ago milk was scoffed at as a beverage for a red-blooded man, but today he knows that it really makes red blood redder. Nowadays, in New York a group of iron workers seated nonchalantly astride a steel girder of a towering skyscraper, eating a man-size sandwich and taking large swallows from a bottle of milk, has become an everyday scene.

Dr. Louis I. Harris of the New York City Department of Health stated, in a recent address: "Unfortunately, the labor groups are not conscious of the significance of health as an asset of transcendent importance to them individually and collectively. They are concerned almost exclusively with questions of wages and hours of labor, which, of course, have a large importance in relation to health and the prevention of tuberculosis; but these are by no means enough to secure the basis for healthful and sane living."

It is one of the aims of the National Tuberculosis Association and its affiliated organizations to educate men and women in the rules of healthful living, thereby making them not only happier but more useful as producers.

In order to further this campaign of education, the eighteenth annual sale of Christmas seals will be held throughout the country in December.



ELECTRICAL MACHINERY FOR LIGHT AND POWER

Action of Relays and Starting Boxes

PRINCIPLE OF THE MAGNETIC BLOW-OUT AND USE OF PROTECTIVE EQUIPMENT EXPLAINED. BY CHARLES G. GREEN*

WHEN AN ELECTRIC circuit is broken at a suitable contact automatically or when such a contact is opened by hand, there is always more or less of an arc which has a detrimental effect on the contacts by burning

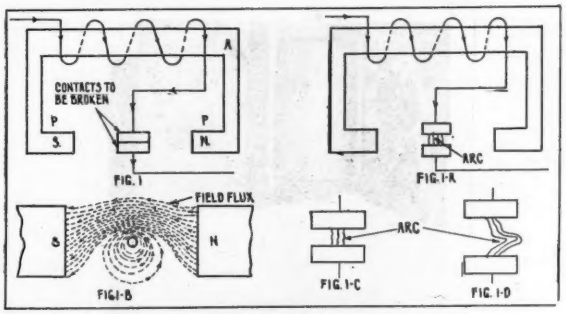


FIG. 1. DIAGRAMS SHOWING PRINCIPLE OF THE MAGNETIC BLOW-OUT

them. This is sometimes prevented partially by the use of two or more contacts on the same contact arm "A," as shown in Fig. 2, the top contact being made of carbon and renewable and the bottom one made of copper. In opening the circuit, the bottom one opens first while the current still flows through the top one either direct or through a small coil as in Fig. 2. After the copper contact, which will not stand much arcing and heat, is opened, the carbon contact opens and any arc which might occur will be at the carbon contacts, which are not as easily burned as copper and are cheaply replaced. If properly adjusted the copper contacts should show no signs of burning with years of service.

There are other ways of reducing the arc at contact points such as, for instance, the use of "magnetic blow-out coil," which deserves some attention here and which the writer believes is sorely neglected in the field. Most maintenance men know that the purpose of this coil and its pole pieces is to extinguish any arc that might occur at the contacts but very few really know the benefit that can be obtained from the action of the magnetic blow-out coils on the arc or by the proper adjustment of carbon and copper contacts. In many cases the small pole pieces of the blow-out coil are so arranged as to be able to turn them up away from the contacts and allow an easy access to contacts for cleaning and adjusting. Too many times the men fail to reset these pole pieces with the consequence that the company soon is put to the expense of buying new main contacts for the starter, not a large bill but one which could just as well have been avoided entirely. In many cases the men who are in charge of this equipment and the men who maintain it do not realize the expense. All they see or understand is the "list price"; they do not figure the time the equipment is out of order, the time it takes to install the new contacts, the time the clerks in

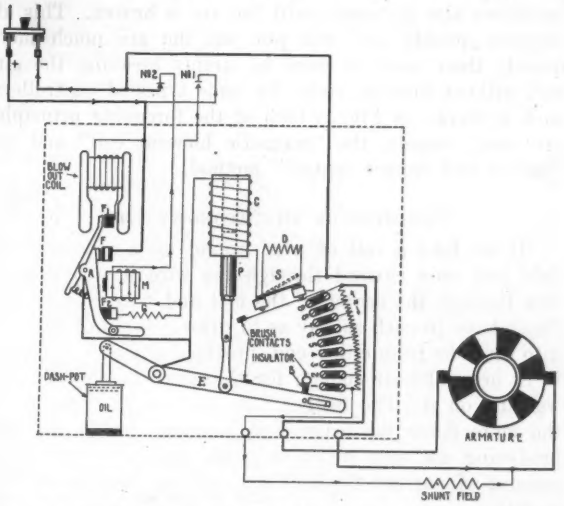


FIG. 2. AUTOMATIC MOTOR STARTER WITH MAGNETIC BLOW-OUT COIL

the office spend checking and mailing orders and also the discredit to him for not avoiding the damage in the first place.

In Fig. 1 is shown a simple illustration of the magnetic blow-out coil principle. Here we have a small iron core A with wire wound on it. Only a few turns of wire are needed but it must be large enough to carry the full load current. This coil is not left in circuit all the time as we will explain later. If the current flows through in the direction indicated by arrows the magnetic poles will be as shown. If, while this current is passing through the contacts, we pull them apart it will cause an arc to be drawn which will tend to damage the contacts. We know that any wire or conductor carrying current will have a magnetic flux set up around it. In this case the arc itself is caused by current passing through the gap between contacts when they are opened. Since the arc is caused by current flow then there must be a flux around it.

To find the direction of any flux, grasp the conductor with the right hand, placing the thumb in the direction

*Instructor in motor department, Coyne Electrical School.

of current flow. The fingers will then point in the direction of the flux around the wire. In this case, we can only place our hand near the conductor which is the arc and let our imagination work a bit as to where the fingers would point if our hand were on the arc. In Fig 1-A the same blowout coil is shown with the contacts broken and the arc spanning the space between contacts. Now, to show the flux action between poles and around the arc, imagine that you are looking at the under side and looking right at the bottom end of the arc. With the direction of current indicated, that is, toward you, if you look at the lower end of the arc, the flux will be as indicated in Fig. 1-B. The flux around the arc will react upon the flux traveling from the north pole in the same manner as the flux around an armature conductor distorts the field flux. The repulsion or reaction of these two fluxes will cause them to crowd apart from each other. The pole pieces being stationary and the arc being flexible, it is natural to suppose the arc is the one to be pushed out of the way, or as we say distorted or blown out. The blowing out is caused by its being distorted from a position shown in Fig. 1-C to a stretched position, Fig. 1-D; when it is thus lengthened it must travel a longer path from pole to pole and as the length of the path is increased the resistance also increases until the arc is broken. This all happens quickly and will put out the arc much more quickly than could be done by simply breaking the circuit without blowout coils. In some types of controllers, such as shown in Fig. 2, both of the foregoing principles are used; namely, the "magnetic blowout coil" and the "carbon and copper contact" method.

Function of the Economy Coil

If we take a coil of wire wound on a non-magnetic tube and send current through the wire it will produce flux through the center of the coil and tube and around the outside in such as way as to draw a piece of iron rod into the tube from either end, provided the iron is started in or brought near enough for the magnetic flux to start working on it. The farther into the coil the iron moves the more dense the magnetism becomes, due to the iron producing an easy magnetic path and with the same amount of current through the coil the magnetism will increase.

When the iron has been pulled entirely into the coil, it will require much less current to produce sufficient flux to hold it there. It is for this reason that on all controllers where the solenoid is made use of, we have what is called the "economy coil," which is nothing more or less than a resistance which is automatically put in series with the coil after the iron is drawn up into the solenoid and the stroke of controller arm completed. This not only saves in the power consumed by the coil but it also saves repair bills. As shown in Fig. 2, the economy coil or resistor is shorted by a short-circuiting strap S, thus allowing the current to flow directly through the solenoid coil, C, which is connected directly across the line. When the iron plunger, P, is drawn up into the coil almost all the way the small set screw, "B," with insulated head presses against the short-circuiting strap, S, and lifts it up to a position shown by dotted lines. This opens the short and the current for the coils C must pass through the economy resistance, D, which cuts down the amount of current passing through the coil, C. This not only saves in power consumption, but saves the coil from getting hot and in time burning out. In many cases where the motor men in charge of equipment do not know the value of this economy coil, they will fail to adjust screw B, and when the plunger and arm E are in the upward position, this set screw does not come high enough to open the short circuit strap or contact and the coil, which is designed to be connected directly across the line for a short time only, will get hot and in many cases burn out. It is well for any man in charge of such equipment to study carefully the operation of each and every part of it. Few if any d.c. motor starters and controllers using the solenoid arrangement do not use the economy coil. Some simple relays such as the magnet, M, Fig. 2, also use the economy coil to good advantage.

Figure 3 illustrates a good type of motor starter. When used on elevators, it is sometimes remotely controlled by a small lever switch, instead of remote control push button switches as shown in Fig. 2. To trace the circuit through this starting box we will assume that the positive and negative lines are as indicated. First we press push

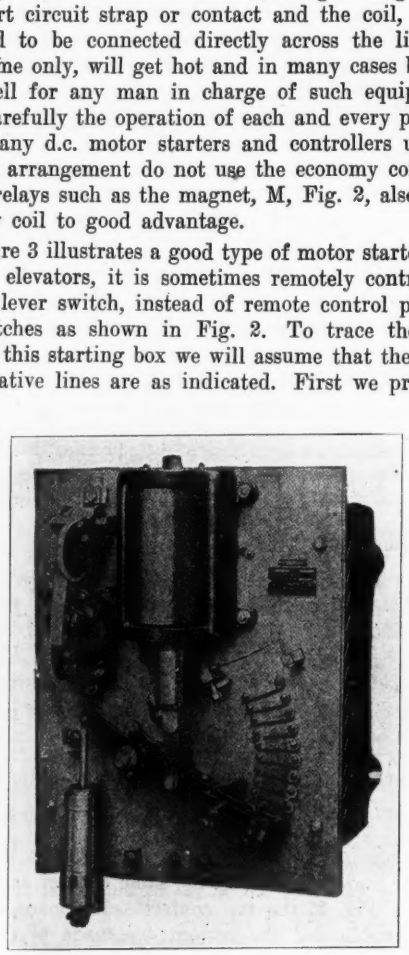


FIG. 3. A MOTOR STARTER OF THE TYPE SHOWN DIAGRAMMATICALLY IN FIG. 2

button No. 1 and current flows through button No. 1 through magnet coil M back through button No. 2 to the negative side of the line.

This energizes the magnet M and attracts the movable arm A which closes contacts F, F1 and F2, the latter two generally carbon. The current now flows from positive through contact F and F1, through the arm A and part of it enters at contact F2, passing through the economy coil G through magnet M, No. 2 push button and back to the line at negative. We can then release button No. 1 and the holding contact F2 will complete the circuit for the magnet, thus holding the circuit closed without the use of No. 1 push button, but through the economy coil G. Part of the current that passes down through arm A leaves the bottom end of it and goes to coil C, through coil C to the short-circuit strap S, through it and back to the negative side of the line. This energizes coil C and starts to draw up the plunger P. As soon as the contact on the end of the lever arm E makes contact with the resistance terminal 1 of the group 1-2-3, etc., we have a flow of current from arm A, down to arm

E, to terminal 1 and through the shunt field in a direction indicated by arrows. Current also flows through full resistance H, to the armature of the motor and back to negative. The plunger continues to draw up and gradually cuts out the resistance H, which was in series with the armature and allows the armature to come up to speed. When the plunger is up, the economy coil is thrown in service as explained before and the two small brush contacts come together with each other, which makes a good copper contact to carry part of the current for the armature. To stop the motor, we can press No. 2 push button and open the circuit for Magnet M and the arm A will drop away, breaking first contact F, which is copper, then F1, which is carbon and carries the arc. When F breaks, the entire current passes through the magnetic blowout coil, producing a flux to blow out the arc which occurs when the contact F1 is opened. When there is no

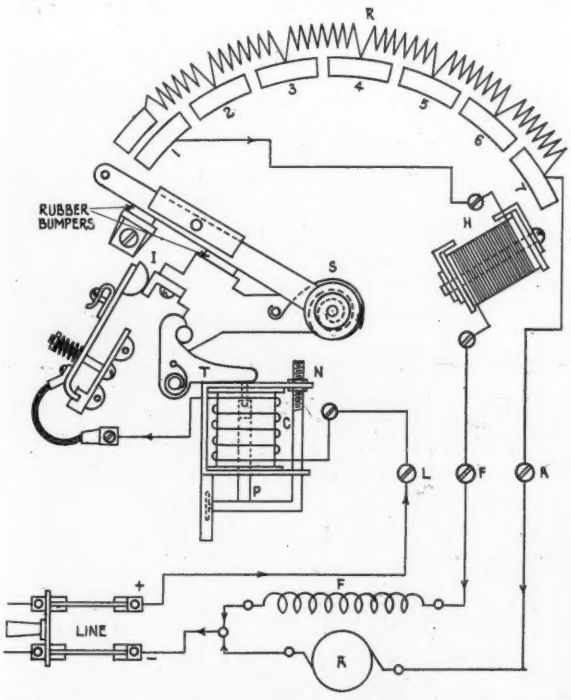


FIG. 4. A HAND TYPE OF MOTOR STARTER WITH OVERLOAD AND NO-VOLTAGE RELEASE COILS

more arc there will need to be no more flux from the blowout coil, but as long as the arc remains, there is proportional current through the blowout coil to produce flux to blow the arc out. This circuit as just traced has been changed slightly to make use of push button control but little trouble will be found in tracing any circuit no matter how complicated, if the simple theory and a few laws of magnetism are studied well.

Overload Release

There must be some arrangement to prevent putting too much load on a motor, thus causing the armature current to become excessive, for the greater the load on a motor, the greater the armature current. An overload release, shown in Fig. 4, takes care of this emergency.

The starting box shown in Fig. 4 shows the overload release mounted on the starting box and forms an active part of it. On the same box, in this case, we have a no-field release coil which also acts as a no-voltage release in case the voltage of the line should fail or if the switch is opened.

Now the action of this overload release coil is extremely simple, but contains the necessary principles that must be understood in order that the maintenance man will be able to understand other types of release coils or safety mechanisms. A coil, C, having a low resistance and only a few turns of heavy wire, is connected in the circuit so all the current entering the starter must pass through this coil to the contact I, through it to the auxiliary arm, which as you will see, is joined to the main arm and spring at S. The current passes up through the main arm or handle to the resistance contacts, 1-2-3, etc., wherever the handle is moved, through the resistance R, to the armature and back to the line. The resistance which has taps taken off at intervals throughout its length produces a voltage drop, so the full line voltage is not impressed on the armature until it has attained a speed sufficient to build up a counter e.m.f., which will then limit the current for the armature in proportion to the load we have connected to the motor. Now, if we bring the handle of the starter over too fast, we decrease the resistance and do away with the voltage drop in the starting resistance, before the armature has come up to a speed sufficient to generate its protecting counter e.m.f., and with a low counter e.m.f., we do not neutralize enough of our impressed line voltage and we get a heavy rush of current through the armature. The current that flows through the armature we traced and found that it must pass through coil C; this increase of current also increases the magnetic flux built up around coil C, and if the current becomes great enough to produce a strong enough flux, it will draw the plunger P up and trip the catch T which will release the auxiliary starting arm, and the tension on spring at S, will pull the auxiliary arm away from contact I, and no more current will flow to the motor, as all the current has to pass through this contact. By lowering the adjusting nut N, we can lower the plunger so it will require more flux to draw it up; consequently, it will require more current to produce this flux and the overload release coil will carry more current, allowing more current to flow to the motor before it trips.

To trace the field circuit we can enter through the overload release, and on to contact No. 1 of resistance, where we find two paths, one for armature circuit and one for field. The one for field branches off from resistance contact No. 1 and goes to the coil H, through this coil to the field, through the field, and joins with the armature lead returning to the line. The current for the field as it passes through the coil H produces a flux which will hold the handle when it reaches point No. 7, and it will be held there as long as there is any current through the coil H and field. If for any reason the field of the motor becomes open so no more current flows through it, then the coil H will be demagnetized, and the handle will be drawn to the off position by control spring S, shutting off the motor before any damage can be done to it, by racing if lightly loaded. In this case it is called a "no-field release." If the field is O. K. and the voltage should be shut off, there would be no current through coil H, or field or armature, and handle will be returned to off position, ready for another starting. In this way we would call it a "no-voltage release."

Great Falls Plant Provides Peak Load Capacity

HYDRO PLANT OF 30,000-KV.A. CAPACITY IS DESIGNED TO TIE IN WITH STEAM PLANTS; DAM PROVIDES STORAGE FOR DRY PERIODS. BY LOUIS R. LEE

ON THE Caney Fork River, approximately 70 mi. from Nashville, Tenn., is located the Great Falls hydro-electric development of the Tennessee Electric Power Co. This development was begun in 1915 and the first unit of 9375 kv.a. was started in December, 1916. The initial development produced a net head of 115 ft. It was later decided to install a second unit, increasing the head by some 35 ft.; this addition was finished in October, 1924. By increasing the head 35 ft. and installing a new stator winding it was possible to increase the capacity of the first and original unit from 9375 kv.a. to 12,656 kv.a., giving a development having the following characteristics. The

FIG. 1. GREAT FALLS HYDRO-ELECTRIC PLANT AND OUTDOOR SUBSTATION, LOOKING UP GORGE TOWARD DAM

power house contains two vertical hydraulic turbine generators, one of 12,656-kv.a. capacity and one of 18,750-kv.a. capacity. These generate 60-cycle, 3-phase power at 6600 v. Power is transmitted at 120,000 v. A dam 75 ft. high gives a net head of approximately 150 ft., the surface area of the reservoir being 2250 acres, equivalent to 6,000,000 kw-hr. of storage.

This development takes advantage of the natural falls and, by means of two short tunnels, receives the water from the Collins River, discharging back again into the Caney Fork below the dam and falls. The development has a fairly large storage basin and the drawdown gives storage sufficient to allow the plant to operate at full capacity for short periods at any time throughout any year or even in extremely dry years. It also allows the plant to carry over short dry periods carrying low load factor load.

FIG. 2. GREAT FALLS PLANT FROM TAILRACE SIDE, WITH SURGE TANKS AND TRANSMISSION LINE TOWERS BEYOND

The plant is somewhat overdeveloped, with the idea that it fits in with steam generation making primary power at a reasonably low cost, considering both the cost of the steam auxiliaries and the cost of operation of both steam and water. The Tennessee Electric Power Co.'s developments are largely in the eastern part of the state and this plant gives them a valuable peak carrying plant approximately half way between Chattanooga and Nashville. Practically the entire output of this plant is distributed in Nashville and the surrounding territory.

Like most rivers in the south, this river is subject to high flood water and it is to be noted that the dam is provided with 18 Tainter gates. These gates, when raised, allow flood water to pass over the dam at the rate of about 150,000 sec.-ft. without causing excessive back water. These gates are raised by electric hoist which runs along on top of the dam immediately below the highway bridge.

Red Cross Calls to Service

NOT EVERYONE is so placed that he can take an active personal part in the volunteer service of the Red Cross but everyone can have a part in that great work. From Nov. 11 to Thanksgiving day is the annual roll call when everybody is invited to join the organization and thus have a part in carrying forward the service to veteran soldiers, fatherless children and those whom disaster has overtaken. The Red Cross serves humanity in every part of the land for humanity's sake. Your opportunity to help is now, by answering the roll call and putting your name on the list.

IN A RECENT ADDRESS, John F. Gilchrist, vice-president of the Commonwealth Edison Co., gave some interesting illustrations of what modern power development involves. In its five principal utilities, Chicago has an investment of $750,000,000 to which annual addition is being made of $60,000,000. The Central station power capacity is 1,400,000 hp. and that number of houses would be a column, 20 abreast, extending from Chicago to Detroit or St. Louis. The cost of the stations and the substations, transmission lines and accessory equipment is well over $200,000,000.

An Amazing Example of Fuel Waste

INVESTIGATION OF CONDITIONS IN INDIVIDUAL POWER PLANT REVEALS A LOSS OF $17,000 PER YEAR. BY FRED C. DEWEESE

SEVERAL YEARS AGO the writer was called upon to make an investigation of a power plant at a certain industrial concern. The conditions were found to be extremely bad, yet no worse than those which exist in a great many plants throughout the country. It is believed, therefore, that the following report submitted to the owners at that time may be of interest to readers of this magazine.

"The following report covers the conditions as found to exist in your plant, together with recommended changes

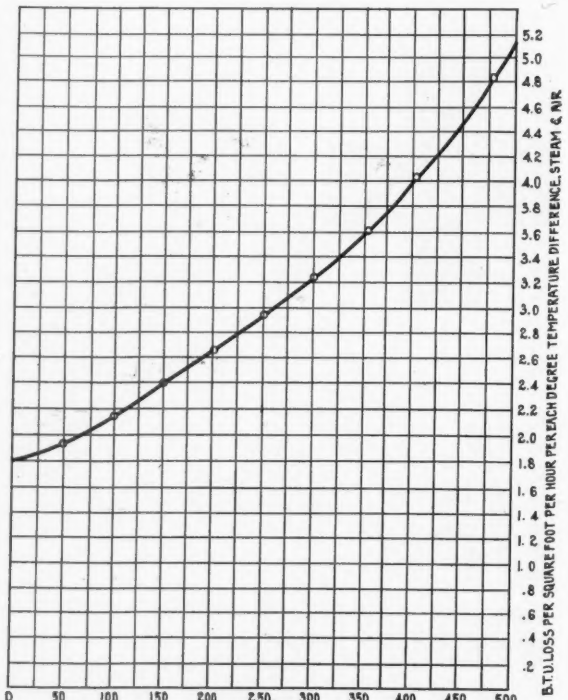


FIG. 1. HEAT LOSS FROM BARE PIPE AT VARIOUS TEMPERATURES*

and improvements which the writer believes should be made at the earliest time possible. There is also appended the estimated cost of making such improvements.

"Please bear in mind that this report is based largely on observed conditions, as no test was made, except for the CO_2 content in the flue gases, which was found to be approximately 4 per cent, on an average. The assumptions as made are based on the writer's experience in other plants and are considered to be exceedingly conservative, as I do not wish to make any statements that cannot be shown well within the limits as covered by the calculations.

"As stated above, the percentage was found to average about 4 per cent, which means that you are heating approximately 417 per cent of excess air, and this corresponds to a fuel loss of 31 per cent of the heat units that are being fed to your furnaces.

"To determine the percentage of excess air for any given percentage of CO_2, subtract the observed percentage of CO_2, in this case 4 per cent, from 20.70, divide the remainder by 4 per cent and multiply by 100. This gives the volume of excess air, or 417 per cent. In rough figures, the preventable fuel loss may be computed by allowing one per cent fuel loss for each 12.11 per cent of excess air above 38 per cent.

"Now, it is one thing to spot a waste and another thing to stop it and after you have it stopped you must keep eternally after it to keep it stopped. One of the largest single items of waste in the whole cycle of power production, and one most common in its occurrence, is the fuel waste directly caused by uncontrolled air leakage. In this connection, let me say that the secret of fuel saving in hand-fired boilers is to maintain an even bed of coal over the entire grate surface, not allowing the fire to become full of holes, as this is a source of great loss of fuel. Holes in the fire permit of cold air rushing through, and this cold air absorbs a great amount of heat that would otherwise be available for steam generation. The proper depth of fire can be determined only after carefully checking the conditions of combustion and draft conditions for various loads, and in this way arriving at results that show the most efficient operating conditions.

EVAPORATION

"Assuming that the coal you are using contains 11,000 B.t.u. per lb., which is about the average for the steam coal of this district, and that your boiler efficiency is 50 per cent. Under these conditions your evaporation would be 5.7 lb. of water per pound of coal and 6.06 lb. of coal per boiler-horsepower-hour.

"It was determined from a previous investigation, that the coal consumption at your plant was, for the last year, 543.5 t. per month, which amounts to 1490 lb. of coal per hour, and is equivalent to

$$\frac{1490}{6.06} = 246 \text{ b.hp.}$$

"The foregoing shows that your plant is developing, on three boilers, which have a rating of 150 hp. each, at 100 lb. steam pressure, 55 per cent of their rating.

"Assuming, as previously stated, 50 per cent boiler efficiency and 11,000 B.t.u. coal, there is available for steam generation 5500 B.t.u. per lb of coal. As your coal cost is $5.20 per t. delivered to the boiler room, the most practical way of arriving at the actual cost of producing steam, is to calculate the problem on a cost per million B.t.u. in the coal, which in this case, is 23.63 cents per million B.t.u. The cost of steam, based on 50 per cent boiler efficiency is $\frac{23.63}{.50} = 47.25$ cents per million B.t.u. in the steam.

"Saturated steam, at 100 lb. gage, contains 1188 B.t.u., and basing the figures on cost per 1000 lb. steam, equals

$$\frac{1188 \times 1000}{1{,}000{,}000} \times 47.25 = 56.13 \text{ cents.}$$

"Attached hereto, and made a part of this report, is a curve showing the loss in B.t.u. per sq. ft. per hour per

*Adopted from tests by L. B. McMillan

degree F. for each degree difference in the temperature of the steam and room temperature.

"As the temperature of steam at 100 lb. gage is 338 deg. F. and room temperature 70 deg. (average) the difference is 268 deg. Reading up from 268 deg. to the curve, thence to the right, it will be seen that the B.t.u. loss is approximately 3 B.t.u. per sq. ft. per hour per degree difference in temperature.

"The area in square feet of uninsulated steam lines in your boiler room is approximately 300, including valves and fittings. The loss from radiation is equal to

$300 \times 3 \times 268 = 241{,}200$ B.t.u. per hr.
$= 241{,}200 \times 8760 = 2{,}112{,}912{,}000$ B.t.u. per yr.
$= 2{,}112.912 \times 0.4726 = \$998.00$ per yr.

The approximate area of boiler feed water lines is 150 sq. ft. The temperature of the feed water averages about 195 deg. F., corresponding to a difference of 125 deg. between boiler feed water and room temperature. The loss in B.t.u. for this is found to be 2.25 per sq. ft. per hour per degree difference in temperatures.

$150 \times 125 \times 2.25 = 42{,}187$ B.t.u. per hr.
$= 42{,}187 \times 8760 = 369{,}558{,}000$ B.t.u. per yr.
$= 369.558 \times .4726 = \$175.00$ per yr.

"The efficiency of 85 per cent magnesia, taken for all sizes of pipe, and 268 deg. difference in temperature, is about 80 per cent. That is, by insulating your steam lines with 85 per cent magnesia you will be able to make a saving of 80 per cent of the heat units that you are now losing from bare pipe.

"The annual loss is seen to be, from bare steam lines and feed water lines, $998 + 175 = \$1173.00$ per yr. As 80 per cent of this is preventable, a saving could be made of

$1173 \times 0.8 = \$938.00$ per yr.

"Some of the steam lines in the boiler room are now covered with Air Cell pipe covering, but judging from its condition, it cannot be more than 25 per cent efficient, and I would advise working this over and adding another thickness to it, or removing it all together and insulating with new material.

There is about 72 sq. ft. of the top of each boiler shell that is covered with red brick just laying loosely and the heat loss through the brick is difficult to estimate with any degree of accuracy, but it must be at least 75 per cent of what it would be without any brick at all on the drums. I would recommend that this brick be removed and the top of the drums be covered with Asbestos-Sponge Felt blocks, finished with not less than ½ in. Sponge-Felt Cement. The efficiency of this covering is 92 per cent. There is about 7½ sq. ft. of the rear end of each drum that is entirely bare, and this should have the same treatment as recommended for the tops of the drums.

Steam Leaks

"From my observation, there is in the boiler room a total of twenty steam leaks that will average the size of a 1/16-in. orifice, and at 100 lb. pressure, a 1/16-in. orifice will leak approximately 13,000 lb. steam per month. The cost will be $13 \times 0.56 = \$7.30$ per month per leak.

$20 \times 7.30 \times 12 = \$1752$ per yr.

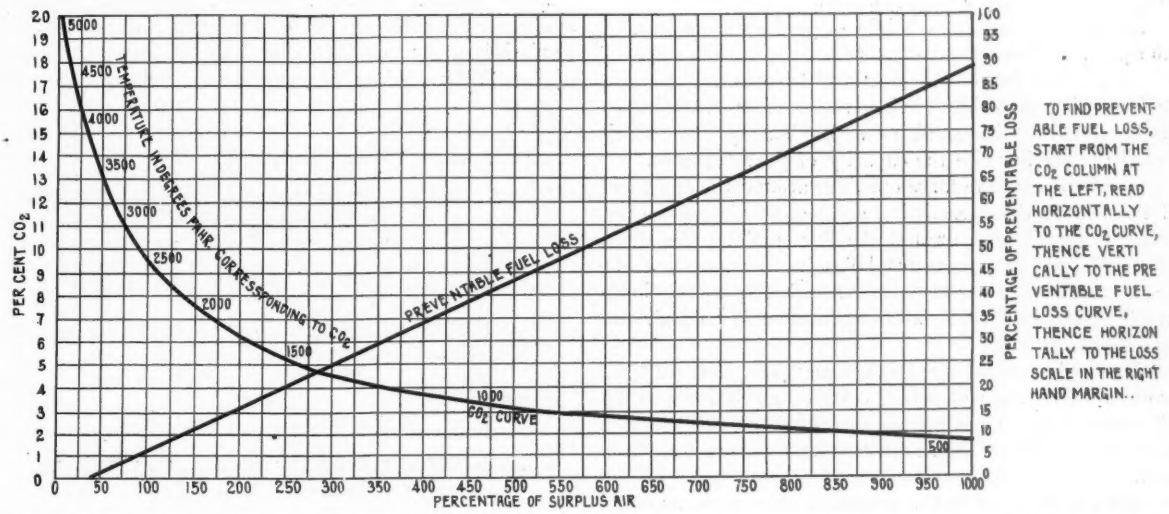

PER CENT CO_2
PERCENTAGE OF PREVENTABLE LOSS
PERCENTAGE OF SURPLUS AIR
TEMPERATURE DEGREES FAHR. CORRESPONDING TO CO_2
PREVENTABLE FUEL LOSS
CO_2 CURVE
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
TO FIND PREVENTABLE FUEL LOSS, START FROM THE CO_2 COLUMN AT THE LEFT, READ HORIZONTALLY TO THE CO_2 CURVE, THENCE VERTICALLY TO THE PREVENTABLE FUEL LOSS CURVE, THENCE HORIZONTALLY TO THE LOSS SCALE IN THE RIGHT HAND MARGIN.

FIG. 2. CURVES SHOWING THE RELATIONS BETWEEN CO_2 FURNACE TEMPERATURES, EXCESS AIR AND FUEL LOSS

There are about 15 steam leaks, that I would say, had an average of 1/32-in. orifice. Each of these will leak approximately 3000 lb. steam per month.

$3 \times 0.56 = \$1.68$ per month, per leak.
$15 \times 1.68 \times 12 = \$302.00$ per year.
$1752 + 302 = \$2054$ per year.

As 95 per cent of this is preventable, a saving could be made from this source, of $2054 \times 0.95 = \$1951$.

Boiler Scale

Fuel loss from boiler scale is one that is difficult even to approximate with any degree of accuracy, as available data on this subject is so conflicting, due to the fact that tests which have been run on boilers with scale of varying thicknesses show quite different results and the varying results arrived at are no doubt caused from the different composition of the scale in different boilers. Some engineers claim that a scale 1/16 in. thick will cause a loss of fuel of 16 per cent. Tests show it to run from 10 per cent to 16 per cent. I have taken a sample of scale from your boilers and find the average thicknesss to be about 5/64 in. and extremely hard. There is no way that the loss from this source can be determined, except by running a test before cleaning and again after thoroughly cleaning the boiler of scale.

The writer believes it very conservative to estimate the fuel loss caused from the scale in your boilers to be 10 per cent. Basing the calculation on this estimate, the cost per year will be

$$\frac{0.1 \times 1490 \times 11{,}000 \times 8760 \times 0.2363}{1{,}000{,}000} = \$3695$$

There is no doubt that this saving can be made by the use of some good boiler compound, or, by installing a water softening plant; however, the need for this is so evident that no recommendations will be offered at this time, but will leave this matter for further investigation.

Smokestacks

Kent's "Steam Boiler Economy," gives, for determining the horsepower of stacks, the following formula:

$$H.P. = 3.33\ (A - 0.6\sqrt{A})\sqrt{H}$$

Where A equals the effective area of the stack, in square feet, and H equals the height in feet.

As your stacks have a height of 48 ft. and an area of 6.6 sq. ft., the horsepower equals

$$3.33\ (6.6 - 0.6\sqrt{6.6})\sqrt{48} = 117.$$

By increasing the height of these stacks to 80 ft. the horsepower would be increased to approximately 160, which would greatly increase the capacity of your furnaces.

The furnaces have large openings around the front end of the drums, thus permitting great quantities of the hot gases to short-circuit around the flues and up the stack. The settings have numerous holes in them, around the doors and through the brick work, so that by merely holding the hand over them, a strong suction of cold air can be detected.

Losses due to the air leakage may be prevented by a more careful system of firing, bricking up and cementing all openings and covering the entire boiler setting with a good boiler wall coating, and keeping the flues free from soot.

(It was shown that the preceding improvements could be made for approximately $2500.00, including everything except a water softening plant.)

The loss due to incomplete combustion is seen to be:

$$\frac{0.31 \times 1490 \times 11{,}000 \times 8760 \times 0.2363}{1{,}000{,}000} = \$10{,}520$$

per yr.

Summary of Preventable Losses

Incomplete Combustion	$10,520
Boiler Scale	3,695
Steam Leaks	1,951
Uninsulated Hot Surfaces	938
Total Annual Loss	$17,100

Annual fuel cost, for coal delivered in the boiler room, is seen to be $35,000 and the percentage of fuel loss is equal to:

$$\frac{17{,}100}{35{,}000} \times 100 = 51.7 \text{ per cent.}$$

The significance of the foregoing becomes more apparent, when you come to think of the fact that you are absolutely wasting one-half of the money that you are paying out for fuel.

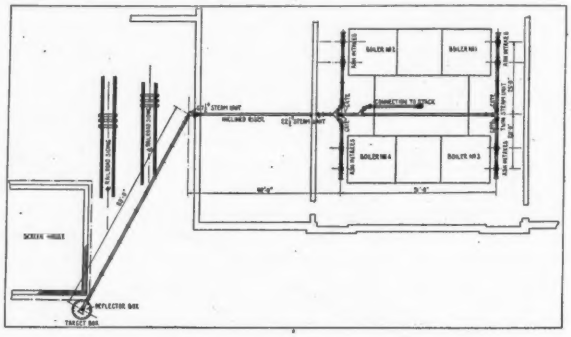
In submitting the report for publication, the writer wishes to emphasize the fact that at last reports there had been no money spent to correct the conditions as outlined. Conditions of waste were so flagrant that only the high points were covered in the report. It was unnecessary to go into great detail to show the enormous waste.

It is believed that many will be benefited by a perusal of these figures, as no doubt many other plants are in the same condition.

When it is considered that about six times the cost for improvements could be saved in one year, it is plainly evident that the management should be held strictly to account for allowing such conditions to exist.

Steam Jet Ash Conveyor in Pulverized Fuel Plant

STEAM JET ASH conveyors have been used with considerable success in both stoker and hand fired plants but few applications have been made in pulverized fuel burning plants. Recently, however, there has been installed at the plant of the St. Paul Gas Light Co. at St. Paul, Minn., by the Girtanner Engineering Corporation of New York a steam jet conveyor for removing the ash

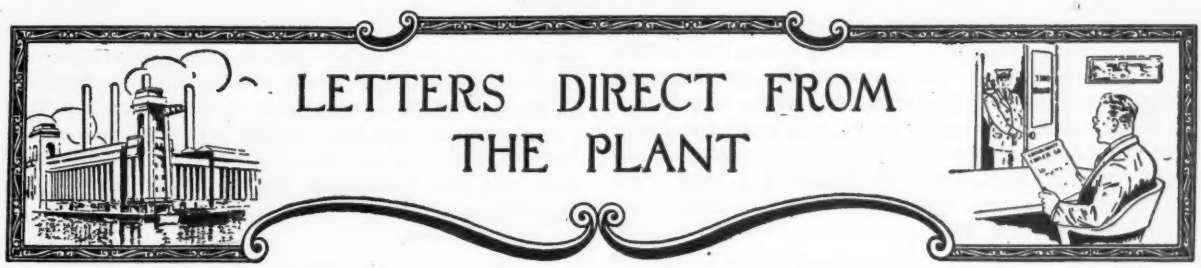


Arrangement Used in Handling Pulverized Coal Ash by Means of Steam Jet Conveyor

from four 1044-hp. boilers burning pulverized coal. The arrangement employed is shown in the accompanying diagram.

The conveyor is 8 in. in diameter and is made entirely of a special, hard, wear-resisting metal with two ash inlets to each boiler. A main header is run between the boilers with a branch to the ash pit door. Air tight slide gates are provided at each branch to place vacuum on the desired section of the conveyor. Near the last branch an additional lateral is installed to provide a branch 6 in. in diameter to remove the fly ash which accumulates in the base of the stack and economizers. At the partition wall of the boiler room the conveyor takes an upward incline of 45 deg. for a distance of about 50 ft., then on an angle of 67½ deg. to the deflector box. The bends, or elbows, are provided with inspection doors and completely lined with sectional wear liners of glass hard metal to resist wear, for a distance of three feet from bends. The steam unit is of similar construction with the addition of a monel metal nozzle and bronze holder, specially designed to operate at high pressure and temperature.

Water is used to remove the ashes from deflector box by means of sluice system to swamp several hundred feet away. No dust is emitted from the line or deflector box, and the vacuum at the ash intakes has a tendency to pull all the dust into the line while being operated. This makes for a very clean boiler room at this plant.



Valve Resetting Fixes a Steam Eater

SOME NEW gearing and rods had been ordered for an engine which had been in a fire and had been assembled and turned over under steam. But while it would run, it was decided to call in outside help. So Bill was called in

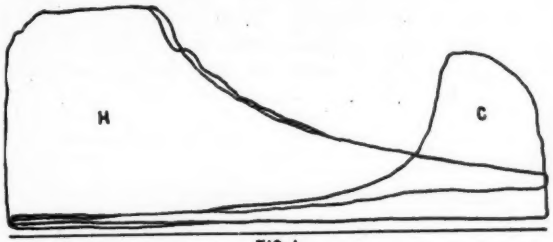


FIG. 1

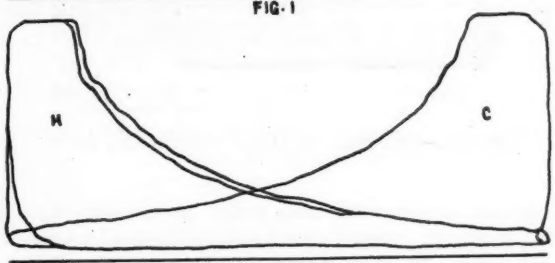


FIG. 2

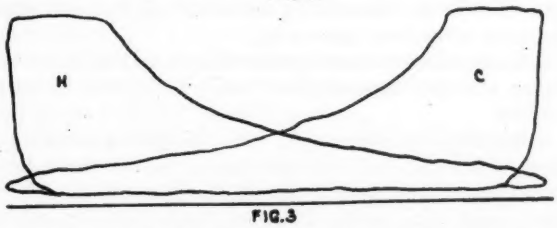


FIG. 3

FIG. 1. HEAD END IS DOING MOST OF THE WORK
FIG. 2. LOAD ON EACH END IS MORE EVENLY BALANCED BUT ALL EVENTS TOO LATE
FIG. 3. FURTHER ADJUSTMENT OF CUTOFF GIVES ACCEPTABLE CARD

with his indicator and a load was thrown on. The engine was run about half an hour and steam pressure was pulled down from 125 lb. to 75 lb. with the fireman fighting the fire. But Bill meanwhile had taken indicator diagram No. 1. This showed the head end doing nearly all the work and, judging by the exhaust sound, it was the truth. The release was high with a slow exhaust valve opening, no compression and a late steam admission. The crank end did not receive full boiler pressure. There was a quick drop after the cutoff and no compression.

From the looks of the diagram, Bill decided to take off the valve plates or bonnets on the ends of the valve chambers and examine the valve setting. The two exhaust valves were found to be upside down and all valve rods needed considerable changing to bring the proper setting with the wristplate central.

Next, the eccentric was loosened and revolved around the shaft while the wristplate was tested for equal travel both ways from mid-position. It was found to be off quite an amount, so this was equalized by taking up on the eccentric and reach rods. The cutoff was adjusted and then the engine was again started and diagram No. 2 was taken. The eccentric was again moved ahead; this gave all events earlier and, with a little more adjusting of the cutoff, finally No. 3 was taken. There was no trouble at all in holding steam pressure then.

Burlington, Ia. TOM JONES.

Money Saved in Power Is Money Earned

MANY obstacles stand in the way of an engineer who is striving to make a record for low power cost, but the greatest is, not how to find a method of reducing cost or improving plant operation, but to persuade the management that he be allowed to make the proposed improvements, which will often call for an outlay of capital anywhere from a few hundred up to several thousand dollars.

In many cases, the saving effected will pay as high as 100 per cent interest on the money invested in improvements but, even where such a high rate of return is possible the plant owners will often refuse to spend anything. Once I was in charge of a plant where part of the power was furnished by a 300-hp., non-condensing Corliss engine and the balance was purchased at 2½ cents per kw-hr., the electrical load averaged 50 kw. and, if the load were added to the load already carried by the engine, that unit would be greatly overloaded. In winter, the exhaust of the engine was used at 3 lb. back pressure for heating and drying and considerable live steam was also used, as the exhaust was insufficient. In summer, only a small percentage of the exhaust was used for drying, the rest going to the atmosphere. The plant contained a jet condenser which could have been used in summer but live steam would then have had to be used for drying, which would have offset the gain by using the condenser.

Annual cost of electric current was nearly $9000 and coal used in summer was 8½ t. daily, operating 24 hr. and in winter about 12½ t., which indicated that the live steam used for heating required 4 t. per day. From tests the water rate of the engine was 23 lb. per hp-hr., at 130 lb. initial pressure and 3 lb. back pressure. Evaporation was high, usually around 9.75 lb. of water per lb. of coal with a water-tube boiler and underfeed stoker, which gave the coal per indicated horsepower, as 2.36 lb.

Now here is the proposition which I put up to the management to reduce our operating expenses. A 75-kw.

generating unit of the vertical high-speed, four-valve type was advertised for sale in a technical journal for $3500, including switchboard, valves and all fittings. This unit had seen less than one year of service and the cost of erection would not have exceeded $500, as a small foundation would serve for this type of engine. A total outlay of only $4000 would have effected the following savings: The annual cost of purchased current would have been eliminated, thus saving $9000 a year.

The coal cost would not have been increased, as will be shown, since in winter the 4 t. of coal used to furnish live steam for heating would easily have been enough to generate 1200 kw-hr. daily (50 kw. × 24). Even with the additional unit exhausting to the heating system, there would have been no excess exhaust as the coal rate would have been much less than 2000 × 4 ÷ 1200 = 6.66 lb. per kw-hr. By running the main engine condensing in summer and using the exhaust of the small unit for the drying operations, the coal rate would not have been increased by over 1⅓ t. The condenser would reduce the coal rate of the engine by 1.7 t. daily (20 per cent of 8.5 t.). At 5 lb. per kw-hr. the small engine would use 5 × 1200 ÷ 2000 = 3 t. daily, so the net increase appears to be 1⅓ t. per day for six months a year. Then 1.33 × 6 × 150 gives $1200 as the amount to be deducted from the gross saving of $9000, which leaves a net saving of $7800 per year as the return on $4000 investment.

But even the prospect of a 195 per cent dividend each year failed to convince the management that they should make the proposed changes, although they had paid $3800 for stokers which effected a saving of only $2000 a year. It is often difficult for the engineer to understand the owner's attitude in cases of this kind, especially where the financial standing of the company is high enough to permit borrowing the required capital at 8 per cent and reinvesting it at 195 per cent.

Now suppose that on this company's property there existed a water power site that could be developed for only $4000 and would save $7800 a year. No time would be lost in developing this project and any number of business men would finance the undertaking, even if the initial outlay was twice as great.

But when the money is needed to improve existing plants, there is at once an attitude of doubt and skepticism. If an order for goods was sent to this factory that showed a net profit of $7800, the firm would immediately spend money to purchase the necessary raw material to fill the order of this customer, and the risk involved in each case is exactly the same.

Brightwood, Mass. A. F. SHEEHAN.

Amateur Manufacturer Deserves Credit

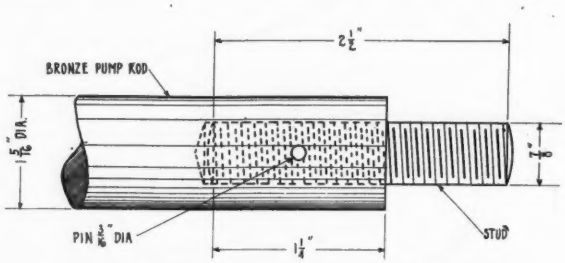
WE NOTE Mr. Schaphorst's letter on page 1065 of the October 15 issue. Might we suggest that Mr. Schaphorst has struck the wrong note when he deprecates the home manufacture of various types of machinery and mechanical devices? It is the very people who are fond of such work who, in the long run, may be credited with the most of the inventions and improvements made in the smaller equipment. Sooner or later, the boy or the man who makes his own machinery for pleasure, designs something which is of real value to the engineering or manufacturing world. It is to the men who made their own radio sets 8, 10, or 12 yr. ago, that we owe so much of the success of radio, both commercially and as a hobby or amusement.

We are inclined to believe that insufficient interest is shown by the young men of this country in making their own mechanical toys and devices. Of course, the manufactured product is the best in the end, but we do not believe that this business of making things in the home workshop is at all to be discouraged.

Foxboro, Mass. L. C. RENNIE.

Repairing a Broken Pump Rod; Stretching a Boiler Tube

AS SHOWN in the accompanying sketch, the piston rods of a double acting triplex pump, as originally installed, were made with diameters reduced from 15/16 in. to ⅞ in. at the end entering the crosshead. This, of course, weakened the rod at the shoulder. After breaking two rods, I found it quite costly to replace them, as they were of Tobin bronze. The crosshead would not stand boring out larger,



BRONZE PUMP ROD REPAIRED WITH STEEL STUD

so we made a ⅞-in. steel stud, drilled and tapped a hole in the pump rod, making the ⅞-in. stud long enough to reach 1¼ in. to both crosshead and pump rod. Then a pin of 3/16-in. diameter, placed through rod and stud, kept the latter from unscrewing.

Those rods which were repaired in this fashion are now much stronger than originally and have given no more trouble.

Recently, we were faced with the job of retubing a shell boiler that had been leaking at the rear head for a long time. This boiler was 72 in. diameter by 20 ft. long, with 5-in. tubes. The new tubes were ordered 20 ft. long but, when replacement started, it was found that the outside tubes were of ample length while those in the center were almost an inch short, due to outward bulging of the rear head. Load conditions demanded an immediate repair of some sort, so, after a lengthy consultation, we concluded to place one tube directly in the center, then roll and bead the front end. Then a length of 4-in. extra heavy pipe was cut into six 3-ft. lengths, heated red hot and all of the six pieces shoved into the tube.

Anxious moments passed waiting for the tube to expand in length enough to reach through the rear head. Soon our efforts were rewarded and, when the tube had reached through far enough to roll and bead, the 4-in. pipes were removed and the tube allowed to cool slowly. After 2 hr., the tube was cool and the bulge in the rear head was gone. As the head was then perfectly plumb, all the rest of the center tubes were found to be the proper length.

Kansas City, Kan. J. F. STALEY.

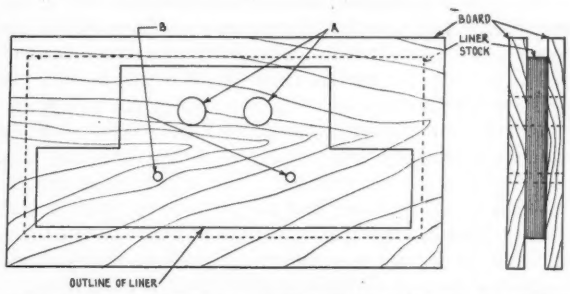
Cutting Out Liners Simplified

OFTEN power plant operators find it necessary to cut out a number of liners or shims of the same size from paper or thin metal. Cutting a few at a time with hand shears takes up valuable time and not all the liners will be of the same size.

An acquaintance recently told me of a method which permits cutting a large number at one time and all of the same size.

Select two pieces of flat board about ½ in. thick and of slightly greater area than the liners, place one of the old liners on one of the boards and as shown in the accompanying figure, mark out the shape of the liner. Next, place a number of sheets of paper gasket material between the two boards and clamp both boards and paper in a bench vise. Then, using a sharp wood bit, bore out the large holes *A* and with a smaller bit, two ¼-in. holes *B*.

Before opening the vise jaws, place two 3/16-in. stove bolts through the ¼-in. holes and tighten up the nuts.



CUTTING OUT NUMBER OF LINERS MADE EASY BY CLAMPING BETWEEN TWO BOARDS

This precaution will prevent the liners from slipping between the boards when the vise is opened. By using a fine tooth hack saw a large number of liners may be accurately cut by following the outline of the liner marked on the outer board.

A similar plan may be used to make metal shims excepting that twist drills should be used to provide the necessary holes instead of wood bits.

Toronto, Canada. JAMES E. NOBLE.

Economical Use of Exhaust Steam

MY INTEREST was aroused in Mr. Sheehan's article on Economical Use of Exhaust Steam in the Oct. 15 issue, page 1048. I agree with the line of action he advocates, that is, replacing old uneconomical engines with modern equipment which will reduce the steam consumption to a minimum. In practically all paper mills today the power requirements are such that they cannot be generated by the drying steam alone, expanded to a pressure at which it can be used in the dryers, so that there will always be an excess of exhaust steam. The actual problem is to make this excess as small as possible.

The day when the engine was merely considered a reducing valve and high steam consumption of no consequence has passed. Power plants are now being remodeled for high steam pressure and superheat and the latest types of prime movers installed for obtaining all of the advantages of high quality steam. When back pressures of 10 lb. or more are to be used it is doubtful if there is any advantage in using uniflow engines, which are specially adapted to large expansion ratios and considerable temperature differences between inlet and exhaust. On the other hand good results can be obtained from four-valve engines with cutoff governing.

It would appear, too, that Mr. Sheehan is rather optimistic in his estimates of auxiliary steam consumption as the feed pump alone for 23,600 lb. water per hr. would take about 1000 lb. of steam, a steam jet air pump 300 to 400 lb. per hr., and the condenser extraction pump (if a jet condenser is used or combined condensate and circulating pump) for a surface condenser 750 to 1000 lb. more, so that it is more likely that the auxiliary steam consumption will run up to 2150 or 2400 lb. per hour as a minimum, provided all the pumps, fans and miscellaneous equipment can be belted from the main engine.

If stokers are installed with a forced draft fan these auxiliary consumptions may be increased from 50 to 100 per cent, in fact the small plant that holds down auxiliary steam consumption to 15 per cent of the total steam is doing exceptionally well. It also seems doubtful if the steam consumptions of prime movers anticipated by Mr. Sheehan can be regularly obtained in operation under varying load conditions so that the prospective saving and possible investment may be difficult to attain, as in figuring these the already small auxiliary steam consumption is reduced by almost two-thirds.

Varying load has a particularly disastrous effect on calculated economies based on bleeding of receiver steam as the steam and load demand never completely synchronize. To cover the possible range of maximum power demand with minimum to maximum bleeding and with minimum power demand, cylinder sizes and ratio cannot be such as to give the lowest steam consumption per horsepower hour obtainable under favorable test conditions.

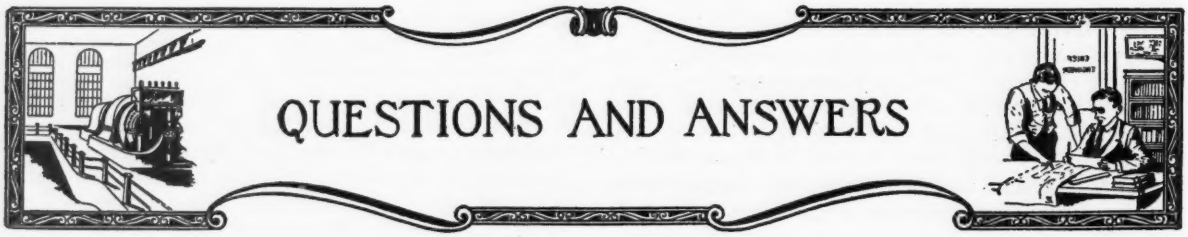
In figuring on investment in new equipment where steam pressure and prime movers are changed radically, spare boiler capacity must be included as it would be almost impossible to get the necessary power out of engines designed for 200 lb. pressure if operated at 125 lb. pressure.

Mr. Sheehan has also neglected to provide steam for heating the make-up water if jet condensers are used or the condensate of the engine if surface condensers are used. This would amount to about 15 per cent of the steam condensed and form an item large enough to be included even in an approximate distribution.

The writer mentions these points not with the idea of discrediting Mr. Sheehan's excellent ideas, which are being put in practice by a number of the more progressive paper mills, but to point out the importance of using more conservative figures in making up estimates of this sort, since there are plenty of cases where excellent and profitable changes failed to satisfy the management and resulted in blame rather than praise for the engineer simply because they could not live up to an over-enthusiastic estimate of the savings they would afford.

After witnessing a number of such changes and having an opportunity to follow up the costs and savings, the writer agrees with the published statement of an executive of a large management corporation that due to the possibility of unforeseen difficulties, in most cases a proposition having no previous experimental foundation should offer a prospective return of at least 25 per cent to warrant its installation. In manufacturing work, where processes are subject to sudden changes, there should be 33 to 50 per cent prospective saving unless the material has a high salvage value.

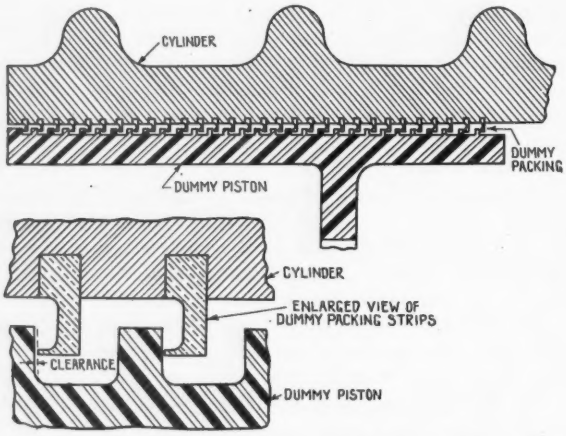
New Haven, Conn. H. D. FISHER.



Dummy Pistons and Packing in Turbines

WHAT are dummy pistons and dummy packing in a steam turbine? A. S.

A. To equalize the end thrust in reaction turbines, balance or dummy pistons are provided. The area of the balance pistons is just sufficient for the steam pressure on them to balance exactly the end thrust of the rotor.



DUMMY PISTON AND PACKING WITH AXIAL CLEARANCE

On these dummy pistons, collars are turned to form a part of the dummy packing. Surrounding the dummy piston is the dummy cylinder. In grooves cut for the purpose, composition rings are secured to the dummy cylinder to form the other part of the dummy packing.

Dummy packing may be either of the axial or radial clearance type. The former type is shown in the accompanying figure. Steam leakage from the high pressure steam chest over the dummy pistons is almost wholly prevented by making the clearance between the edges of the packing rings and the collars on the dummy piston quite small. In practice this is from 0.015 to 0.030 in.

Dummy packing is also called labyrinth packing since, as the name suggests, it forces steam to follow a long winding path.

Steam, in passing through each constriction in the path, is subjected to a throttling action with a consequent reduction in pressure.

Economics Must Determine Prime Mover

OUR HEATING season covers 7 to 8 mo. of the year and the heating plant consists of three 80-hp. boilers and one 125-hp. boiler, tested for 100 lb. pressure. They are usually operated three at a time, as it never has been necessary to use the entire group at once. The steam pressure in the boilers is usually held at 60 lb. and let into the heating mains at 10 lb. We have a vacuum return. What I wish to know is whether or not it is practicable to use this steam in a turbine generator before releasing it for heating duty. Will turbines operate on as low a pressure as we have available? If they could, would the cost of installation and maintenance be justified when at present our bill for electric current is $250 per month? H. R. P.

A. The whole question is primarily one of economics rather than of engineering and we believe it should be considered first from that standpoint.

First, is it advisable to continue to purchase current or to generate your own? Many engineers in reply to this question will say—"If you can generate current for less than 1.5c to 2c per kw-hr., then, by all means do so." In your particular case, where it is necessary for you to operate heating boilers in any case, we believe that you could generate current for this price. You do not state, however, just what you pay per kilowatt-hour for purchased current. It seems to us, however, that since you must operate your heating boilers, a turbine or engine inserted in the steam line will act simply as a reducing valve and that you will be getting your power as a by-product of your heating.

To determine this, it is necessary to consider the cost of new equipment and the operating cost. In your case, it will not be necessary to spend any money for boilers and little for other boiler house equipment. The biggest investment will be in some sort of prime mover and the proper piping and electrical connections for it. The question of whether or not this prime mover should be a turbo-generator or an engine driven generator should also be given consideration. It is possible for you to obtain a turbo-generator to operate on 100 lb. pressure. The turbine manufacturers can help you here. It might be a good plan to use a bleeder turbine; that is, one in which the connections are so arranged that part of the steam can be taken out for heating before it has passed entirely through the turbine, the remainder going into the low pressure part of the turbine and finally into a condenser. In this way, you might gain more economy during the summer season, when steam would not be required for heating. On the other hand, it might work out that the best type of turbine would be a straight non-condensing turbine, although from such a superficial examination as this, we do not think so.

It might be possible, however, to consider the installation of an engine of either the uniflow or poppet valve type, which, under such circumstances, usually give good results. In any event, a careful comparison of initial investment and operating costs of both the steam engine and the turbine will repay you.

One other type of prime mover should not be left out of account, that is, the Diesel engine. It has been found that for such cases as yours this engine possesses advantages that are worth considering. In the first place, there are no stand-by losses; in the second place, operating costs are usually lower and third, by utilizing the heat from the

exhaust gases and the heat of the cylinder cooling water, it might be possible to satisfy your heating requirements in this way. Possibly, at small cost, your present boilers might be equipped to utilize this waste heat for heating steam. Then, there is the question of whether or not you could burn oil under the boilers instead of coal when using a Diesel engine and whether or not it would be well to do so. We suggest that you give careful consideration to the possibility of using a Diesel engine.

Factor of Safety Governed by Load

IN steam boiler design, what is meant by a Factor of Safety of 5? C. W. S.

A. The ratio of the ultimate strength of the material to the working unit stress is the factor of safety. It indicates, to a certain extent, the degree of security against rupture. The factor of safety to be used for any particular case depends on the uniformity of the material, the mobility of the loads carried and the degree of certainty with which the stresses sustained can be computed.

The average values of factors of safety of the following materials under different character of stresses are as follows:

	Character of Stress		
Material	Steady	Variable	Shocks
Wrought iron	4	6	10
Medium steel	4	6	10
Hard steel	5	8	15

Instead of using factors of safety, it is becoming customary in designing to fix the maximum stress in pounds per square inch which will be allowed on a piece. Thus, in designing a boiler, instead of naming a factor of safety of 6 for the plates and 10 for the stay bolts, the ultimate tensile strength of the steel being from 50,000 to 60,000 lb. per sq. in., an allowable working stress of 10,000 lb. per sq. in. on the plates and 6000 lb. per sq. in. on the stay bolts may be specified instead. Thus you may see that the factor of safety designates what fraction of the ultimate tensile strength the allowable working stress is to be.

In other words, a factor of safety of 5 means it will require a force five times as great as the allowable working stress to reach the ultimate tensile strength.

Fuel Saving but No Efficiency Increase

How much can we increase the efficiency of our boiler if we increase the feed water temperature from 150 to 200 deg. F.? A. N.

A. Efficiency cannot be increased by raising the feed water temperature but there will be a saving in fuel, provided the water is heated from a source of heat which would otherwise be wasted. You have not stated the boiler pressure which must be known in order to figure the fuel saving. Assuming 125 lb. gage pressure, the saving under the foregoing conditions of feed water temperature will be 4.64 per cent. This is found by the formula:

$$\frac{100\,(T-t)}{(H+32)-t} = \text{Per cent fuel saving}$$

where,

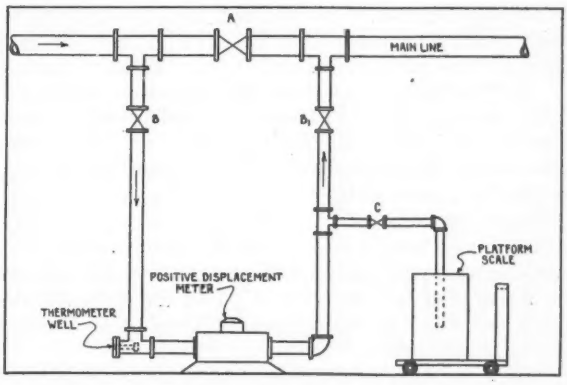
T = temperature after heating
t = temperature before heating
H = total heat in steam at boiler pressure

$$\frac{100\,(200-150)}{(1193+32)-150} = 4.64 \text{ per cent}$$

Fuel Oil Meter Hook Up

PLEASE recommend a method of installing a meter for heavy fuel oil, so arranged that the meter can be calibrated without removal from the line. What type of meter is best for heavy oil? A. N.

A. For use with heavy fuel oil, a positive displacement type of meter gives the best results. As shown in the accompanying figure, a meter of this type is connected to the main fuel oil line in such a way that by closing block valve *A* and opening valves *B* and B_1 oil must pass through the meter as in normal operation.



CONNECTIONS TO FUEL OIL METER PROVIDE FOR BY-PASSING METER WHEN TESTING METER READING. PLATFORM SCALE USED TO CHECK METER VOLUME BY WEIGHT

If it is desired to test the meter, this may be done without shutting down the burners or removing it from the line. First open valve *A* and then close valve B_1; it is not necessary to operate valve *B* at all. Next, provide a platform scale and a 10 to 15 gal. can. By opening valve *C*, the can may be filled and the oil weighed.

By noting the number of gallons passed through the meter, this volume may be compared with the weight shown on the scales by converting the volume figure to one of weight. This may be done by determining the specific or Baume gravity of the oil with a hydrometer.

Assume for example, that the meter showed 10.0 gal. passing through and the hydrometer test indicated a Baume gravity of 16.2 deg. From tables it may be found that oil of this gravity weighs 7.98 lb. per gal. If the meter is correct, the oil in the can on the scales should weight 79.8 lb.

Now suppose that the actual weight is shown as 81.25 lb. This would mean that at the particular temperature at which the test was run, the meter allowed too large a volume to pass through to give the correct weight.

To remedy this, the stroke of the meter pistons should be shortened slightly to give a decreased volume at this same temperature. By adjusting the set screws on the ends of the cylinders, the above-mentioned volume may be reduced until the converted weight of the meter reading checks with the scale reading.

CIRCULATING or cooling water for oil or gas engines should be pure. Don't fill the cylinder jackets with scale by using hard water.

AN EDUCATED MAN is a man who can do what he ought when he ought to, whether he wants to or not.

EDITORIAL COMMENT

Trends in Public Utility Ownership

In spite of all that has been done to counteract the opinion, the average man still makes little distinction between the doctrines of the socialist, the anarchist and the communist. The average business man has a tendency to lump all three together under the term "dangerous radical."

In attempting to overcome the various movements to bring about government ownership, the public utility executive, we find, often falls into the same error. In a recent speech by such an executive, we note a statement referring to the "pernicious socialistic doctrines of government ownership," that form an influence against which the public utilities must issue a counter-attack. There seems to be a need for some public utilities, in case they fear the influence on America of the doctrines of public ownership, to discover just where those doctrines originate before attempting to attack them.

It is true that one of the doctrines of the Socialist group has been, and to a limited extent still is, the doctrine of government ownership of utilities that influence the lives of a great number of people. But John Spargo, who is considered the brains of the socialist group in this country, recently wrote the following: "As a means of attaining the greatest advantage, government ownership appears to me to be inherently inferior to the new type of enterprise we are so rapidly developing, characterized by popular ownership, representative management and social regulation." A man who holds such doctrines, whether he is classified as a socialist or not, can surely not be considered a "dangerous radical," deserving of deportation by the next steamer.

We are not attempting any defense of the socialist party and its doctrines. The capitalistic system under which we are now operating may not be the best possible system, any more than the Corliss engine is the best possible prime mover under all conditions. But the capitalistic system does produce some result, which is more than can be said of many other systems that have been tried. Our point here is that the intelligent socialist has recognized that times change and that his doctrines, too, must change to keep pace with the development that goes on regardless of man-made laws.

On the other hand, every well-informed citizen of this country knows that the greatest amount of agitation for government ownership in this country comes directly from communist headquarters, although it may be transmitted through labor leaders and prominent socialists who are unaware that they are acting as cat's paws. Yet there is little to fear from their influence and their drive for government ownership of everything, provided the public utilities let the general public know what they are doing. It is all very well to explain the present-day organization of industry in articles in the general magazines of the country. But these magazines are seldom read by the people to whom the public utilities wish to explain the principles of "popular ownership, representative management and social regulation," referred to by Mr. Spargo. Those people read the newspapers, and it is there that the public utility can tell the whole story to the people it wishes to reach, the people who are most easily reached from the other side by communistic influences.

It would be well for the public utilities to go directly to the root of the government ownership propaganda by explaining to the general public, instead of to the men who are already aware of it, the fact that we now have what is much better than government ownership. If they do that, they have little to fear from those who would take away the right of man to own the things he produces by his labor and his intelligence.

Are We Burning Coal, or What?

Some days it seems as if we're trying to burn rocks but that isn't the reason for this question. Here comes the statement from the Fuels Division of the American Society of Mechanical Engineers that "Millions of tons of coal containing products equal to or greater in value than average quartz from the famous Homestake (gold) mine are being burned annually with no attempt at by-product recovery" and that "Attempts to burn these by-products result, for the most part, only in inefficient and smoke-producing combustion."

This statement also quotes Franz Fischer that while proximate and ultimate analyses of coal are important from the scientific and technical points of view, they tell the chemist no more concerning the chemical compounds that constitute coal than a reader would learn of the contents of a book if told that its contents were 15 per cent of the letter *e*, 5 per cent of *n*, 1 per cent of *g*, 4 per cent of *b* and so on. Reader or chemist must know the groupings into words and sentences, into atoms and molecules to get any knowledge of the value of the book or of the coal.

Now, what are these valuable by-products which are being wasted? We know that we burn gas and coke and tar and there is also a "gas liquor" as one of the volatiles in coal. What then? Well, from the gas comes 11 derivatives besides illuminating and fuel gas, all valuable chemicals including benzol, used for motor fuel, and Prussian blue a valuable dyestuff. The gas liquor yields 7 derivatives, ammonia and its compounds. Coke gives 10 products, as cokes, graphite and substances made from these. But tar—it divides into light, middle and heavy oils, refined tar and pitch and then the fun begins. Each of these has a multitude of derivatives running from perfumes and flavoring extracts to explosives, roofing and paving material. It seems that the tar barrel contains something for everybody; acids, dyestuffs, wood preservatives, motor fuel, photo developer, pipe coating, insulation, disinfectants, medicines, shingle stain, or what do you want most?

What are these worth? What do you pay for dyes or aspirin or carbon electrodes or hydroquinone developer? There are production and distribution charges but compare the prices of these things per pound with that of coal. The margin looks promising.

When you shovel coal into the furnace or feed it to a stoker, all these things go in too. And, if they are making trouble in getting good combustion, why not get rid of them beforehand? Here seems a real problem in combustion engineering with money-making possibilities for those who find the solution.

Watch That Coal Pile

This is the time of year when the huge reserve coal piles, found all over the country at large central stations and in industrial plants, need close watching to prevent incipient fires from spreading.

Spontaneous combustion is responsible for the starting of these fires, but authorities as yet do not know enough about the action to formulate rules which will prevent fires under all conditions. They have learned, however, that the condition of the coal at the time of storage and the manner of storage have considerable bearing on the question of fires.

Coal stored in hot and rainy or humid weather shows marked tendencies to ignite when the weather gets cooler, especially if care has not been exercised in preventing segregation of particles. "Peaking" or pyramiding the pile is dangerous. If you have a pile of this shape, the space between the large lumps on the outside will admit air to the fine material within and there is always danger of a fire. Spontaneous combustion cannot occur when air is excluded.

One excellent method of checking a coal pile for hot spots is by the use of a specially designed thermo-couple made in the form of a spear, which can be driven into the pile. Fires start from 4 to 6 ft. beneath the surface and if the temperature is found to be much over 100 deg. F., the coal at this point should be removed.

Even if a fire has actually started, it is better not to use water unless it covers considerable area. The important thing to be remembered is that if water is used at all, the burning portion must be thoroughly soaked and then removed. If this is not done, in a majority of cases fire will break out again.

Storage under water affords a sure protection against fires, but this method is not feasible in many plants. An alert yard crew can do much toward preventing fires in coal piles by constantly patrolling the pile and removing portions which show signs of steaming or heating.

Off Duty

Off Duty? Well, maybe, but not for a poor overworked technical editor. To him, Off Duty is a myth—an ideal, so to speak, which always lies just beyond an ever-changing horizon. He dreams about it and forever labors under the happy delusion that it's going to bob up any moment, but that moment never comes. He doesn't realize that fate has stacked the cards against him and that around the corner of each issue, ten thousand other issues await his caressing touch. He is never finished. After each issue is out and before the next, ten thousand readers lay for his scalp—they are always laying for his scalp. Anything he does, anything he tries to do or even suggests, someone, somewhere, is certain to arise out of the unfathomable gulf that separates him from his readers, and attempt to annihilate him. Compared to an editor's lot, Kit Carson had a snap—Stanley's explorations in darkest Africa were the joyful rompings of children playing on the lawn. Off Duty for an editor? Bah!

A technical editor must be a combination oracle, spiritual adviser, poet, philosopher and scientist. He must possess the patience of a wooden Indian, the endurance of an iron horse and the compassion of a weeping willow. He must have the mental agility of a Philadelphia Lawyer, the diplomacy of a peace pipe and the equanimity of an oyster. Above all he must be a humorist of the first water; in fact, it is largely his unfailing ability to see something funny in the most tragic occurrences that is responsible for his pitiful clinging to life.

Imagine for a moment, dear reader, what would you do to Jim Berzak of Pohakia who writes in and asks, "deer editor, how is an electric motor and why? Please answer by return mail." Or to Professor Smalley who informs you in a communication that the article in your last issue on how to solder a flywheel with chewing gum, is d——d rot because on the face of it, flywheels are true and therefore do not wobble. Or to the learned subscriber in Etah, Greenland, who writes in and says that Joseph McSlinker's article on repairing refrigerators with cat-gut is silly because there ain't no such thing.

Then there is the letter which modestly asks us to send by return mail (always by return mail) complete specifications and detailed drawings together with photographs of a 13,562-hp. power station to be used with a rubber plant in Bolivia. And again, as the result of publishing an article on heat transmission through furnace walls, Aloysious McClancy Surrett, B. s. Q. S. T. indignantly comments that heat transmission through furnace walls is nothing more than a dynamic illusion, and to prove it submits a lengthy dissertation on the electronic reactions of an inebriated B.t.u. under the influence of a rarified, ethereal pressure.

Think of it, gentle reader. Imagine wearing your precious life away trying to make head or tail out of all this. And that's only half of it. I have said nothing about malicious printers who are forever trying to get something on him and who, in their cute way, make life even more miserable—if that is possible.

Yet, through it all the editor remains at the helm; sometimes with tears in his eyes, sometimes with the burning fires of revolt flaring up in his breast, but he holds on. At times, it is true, his firm grip on the wheel weakens ever so slightly and the ship of progress falters and trembles but invariably before the deviation in the course becomes perceptible he regains his composure and the world little recks how nearly progress has been smashed on the rocks of oblivion.

The technical editor! What a responsibility fate has thrust into his care! What a task; indeed, what an imposition! How can human intellect be expected to cope with superhuman problems? How can mortal man bear up under the burdens which fate ruthlessly flings daily upon the shoulders of the poor technical editor?

But he is not complaining; indeed, he feels the importance of his lot in life and although extremely modest, often takes a certain amount of pride in his superhuman accomplishments. He can bear up under it all if he is not openly jeered at or ridiculed. But when, from under a Mt. Everest-like mass of Mss. and valued communications from his readers, he sometimes gets a glimpse of the calendar and discovers to his confusion that he must write an article on "Off Duty," that is, truly, the last straw—life becomes hard and his morale lowers.

New York Power Show Will Be Nov. 30 to Dec. 5

DETAILS AND SPECIAL FEATURES OF THE INDIVIDUAL EXHIBITS SHOW THE VALUE OF ATTENDING TO STUDY ADVANCES IN POWER PLANT PRACTICE

ON MONDAY, November 30, the Fourth National Exposition of Power and Mechanical Engineering will open at 2 p. m., at the Grand Central Palace, New York City and will extend through the week, ending December 5, opening each day at noon.

Its basic purpose is to bring together exhibits of power and mechanical equipment so that engineers and industrial executives may have an opportunity for comparative study of the outstanding developments in the field. The manner in which the Power Exposition has developed during the past 3 yr. shows that it is filling a useful place in the tremendous development in power generating and power using devices.

Decreased use of coal per ton of freight hauled on the railroads and increased thermal efficiencies of central power stations furnish two examples of the manner in which modern engineering is keeping step with the increased demand for greater economy in the use of fuel. The constantly turbulent condition of the coal industry furnishes incentive to all manufacturers who use power and heat to devote increasing attention to better economies in their power plants. To assist in securing these economies the Power Show brings together all types of equipment under one roof with competent interpreters of the importance of each device in attendance.

Devices to increase the effectiveness and economy of combustion will be found at the show; air preheaters, pulverized fuel equipment, stokers, water-cooled boiler furnace walls, soot blowers, and draft apparatus.

Addition of heating and ventilating equipment broaden the show for the heating and ventilating problem in a factory or an industry is closely allied to the power problem and each is tied to the other.

Machine tools and equipment used in machine shop practice will form a large and important group of exhibits among which are many new and novel machines.

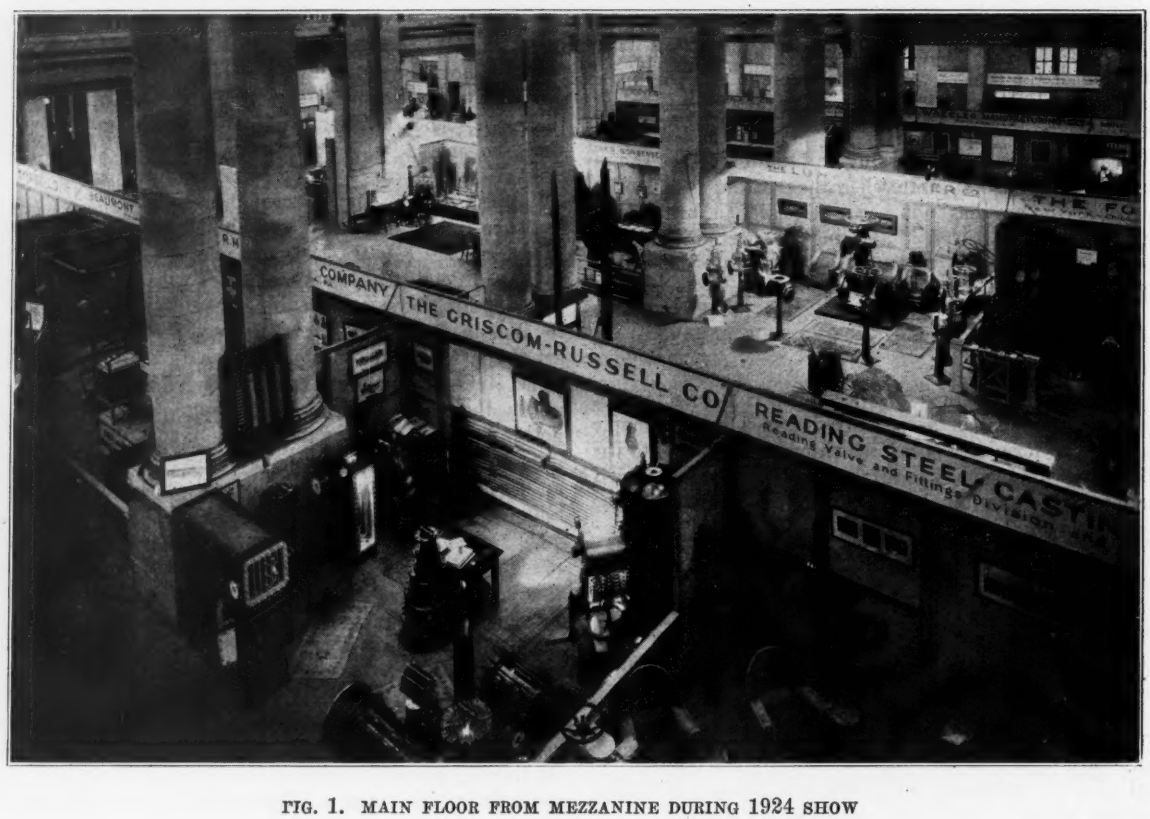


FIG. 1. MAIN FLOOR FROM MEZZANINE DURING 1924 SHOW

In the following pages will be found the chief details of each exhibit, with the booth where it may be found, so that readers may determine what features they wish to give special study. To give an idea of locations, booths 2 to 95A will be found on the main floor, 201 to 347 on the mezzanine floor and 401 to 569 on the third floor.

Grand Central Palace is on Lexington Ave. between 46th and 47th Sts., and is conveniently reached by the Lexington Ave. surface line, the east side elevated or the east side subway lines. Managers of the show are Fred W. Payne and Charles F. Roth with offices in the Grand Central Palace, New York.

Accurate Brass Casting Co., Cooper & Wyckoff Aves., Brooklyn, N. Y., will exemplify its method of casting to close dimensions and the nature of its product in booth 476.

Ackerman-Johnson Co., 625 W. Jackson Blvd., Chicago, will display its line of specialties in booth 423.

Advance Engineering Co., 168 Washington St., New York, will be in space 275-276 as representatives of A. W. Cash Co., and Armstrong Machine Works.

Aero Pulverizer Co., 165 Broadway, N. Y., will exhibit its unit pulverizer system in space 319-320, and explain the special construction of manganese-steel working parts and roller bearings, also the action of the heavy paddles and the side-dump iron separator.

Alexander Brothers, 14 South St., Philadelphia, Pa., will exhibit in booth 434.

A. Allan & Son, Harrison, N. J., will exhibit in booth 483 its Allan line of bearing metals and packings. Among these will be Red Metal, bearing bronze, and metallic packing for piston rods, valve stems and air pumps.

The Allen-Sherman-Hoff Co., 254 S. 15th St., Philadelphia, Pa., will have booth 75 in which it will display a miniature Hydrojet ash-handling system. This will be comparable to a commercial installation but made up of small unit parts so as to meet space requirements in the booth. It will have the regular Hydrojet features, horizontal sluiceways, high water velocity, intermittent discharge of ashes and feed of material by auxiliary nozzles, which wash accumulated ashes slowly into the sluiceway whence they are carried to the sump. The system will be shown in operation.

The Louis Allis Co., 133 Stewart St., Milwaukee, Wis., will show the special construction of its motors and the detail of the indestructible rotor used in the H-D type in space 445-446.

Allis-Chalmers Co., Milwaukee, Wisconsin, will have its exhibit in booth 470. This will include its entire line of power plant equipment, steam and hydraulic turbines, steam and gas engines, electrical machinery, pumps, air compressors, hoists, power transmission equipment and special machinery for mining and metallurgical work, crushing, cement mills, flour mills, saw mills and timber preservation.

Alsop Engineering Co., 47 W. 63rd St., New York, will display in booth 212, a line of mixing machines and portable pumps.

American Arch Co., Inc., 17 E. 42nd St., New York, will show in booth 58 its suspended arches built of angle carried on cross pieces and supporting pressed steel clips for the suspended and interlocking filler tile. That renewal of any section is readily accomplished will be demonstrated at the exhibit. All steel is out of the heat zone and the construction allows for expansion.

American Blower Co., Detroit, Mich., will have in space 296-297 a forced-draft blower, driven by direct-connected motor, in operating condition. Also it will show its line of ventilating and heating equipment as well as boiler room apparatus.

The American Brass Co., 25 Broadway, New York, will feature at the coming Power Show in booth 65 many products essential to the power plant and the development of engineering equipment. The exhibit will include condenser tubes of both Admiralty and Muntz Metal and a new tube of special merit known as Anaconda AA; turbine blading made of nickel bronze, manganese copper, cupro nickel and monel metal; copper bus bars and tubes; commutator bars and segments; tobin bronze turned piston rods and shafting; bare, insulated and weatherproof wire; lead sheathed power transmission cable, paper or varnished-cambric insulated. It is also planned to exhibit the complete Anaconda line of sheet, wire, rods and tubes, an interesting section being that devoted to die-pressed parts and extruded sections.

American Car & Foundry Co., 165 Broadway, New York, will meet its friends interested in coal cars, industrial railway systems and material handling in space 207-208.

American Chain Co., Inc., Bridgeport, Conn., will have in booth 48, an exhibit of its chain for sash, cranes, hoists and other uses.

American District Steam Co., North Tonawanda, N. Y., will have in its display, booth 475, a line of expansion joints for hot water, oil and steam pipe lines, featuring specially the Duplex-sleeve joint for high-pressure and superheated steam. This joint allows circulation of air between the sleeve through which steam passes and that part of the sleeve bearing against the packing, tending to lengthen the life of the packing and keep a tight joint. Several types of underground steam line construction, with actual methods of installation for high and low pressure will be featured, also specialties for the Adsco system of atmospheric steam vapor heating, and reducing valves, steam traps, steam-flow and condensation meters.

American Machine & Foundry Co., 5520 2nd Ave., Brooklyn, N. Y., will exhibit rotary pressure and vacuum pumps, automatic water supply systems and strainers in its space 429-430.

The American Pulley Co., 4200 Wissahickon Ave., Philadelphia, Pa., will have as three principal features, in space 530-531, its standard lines of steel split belt pulleys, pressed steel shaft hangers with ring-oiled babbited bearings and pressed steel hand trucks. Also will be shown interchangeable bushings, shifter arm attachments, car wheels, steel reels and spools and other articles of pressed metal.

American Resistor Co., Milwaukee, Wis., will be found in space 524-525. It will show non-metallic heating elements capable of operating up to 2750 deg. F., high-speed heat-treating furnaces in which these elements are incorporated and in operation at 2450 deg. F., and a small assay furnace operating up to 3000 deg. F. Display will also be made of fireplace and portable heating units for domestic use, the entire exhibit being planned to illustrate the application of Globar units to domestic and industrial use and their actual operation.

American Schaeffer & Budenberg Corp., Berry and S. 5th Sts., Brooklyn, N. Y., will have in booth 74, a complete line of instruments for increasing power plant efficiency, including indicating and recording gages, indicating and recording thermometers, pressure and temperature controllers, tachometers and the like, of particular interest will be a new, inexpensive dial thermometer of universal application.

American Society of Mechanical Engineers, 29 W. 39th St., New York, will use its booth 80, as a headquarters for members of the Society and will have on hand samples of its publications, the booth being fitted as a rest and reading room.

American Temperature Indicating Co., Toledo, O., will display its line of temperature measuring and recording instruments in booth 510.

Anaconda Copper Mining Co., 25 Broadway, New York, will exhibit raw copper and copper products in its booth, 65.

Andale Engineering Co., 522 Walnut St., Philadelphia, Pa., will have its exhibit of duplex water and oil strainers in booth 92.

Arca Regulators, Inc., 452 Lexington Ave., New York, will have in space 213-214 its various types of automatic regulators for use in power plants. These cover control of combustion and feed water for boilers, temperature for feed-water heaters and oil heaters, reducing valves, make-up valves and de-superheaters. Liquid pressure is used for operating power and the jet principle to secure sensitiveness and accuracy, with a compensating device to obviate hunting.

Armstrong Cork & Insulation Co., Pittsburgh, Pa., will have a display of insulating materials for high and low temperatures in space 334-335. Among these will be Nonpareil high-pressure covering and blocks for steam lines and machinery, Nonpareil and Armstrong insulating brick for boiler settings, furnaces and other high-temperature use, Nonpareil cork covering for refrigerated pipe lines, Armstrong's Corkboard for cold-storage room and roof insulation.

Armstrong Machine Works, Three Rivers, Mich., will exhibit in booth 275. Various sizes and styles of its traps will be shown, including steel steam traps for high pressure and superheat. Demonstration will be made of the action of the Armstrong trap by means of a glass body and bucket which will show the operation of the inverted submerged bucket, and the non-air-binding, self-cleaning and absence of wire drawing features.

The Ashton Valve Co., 161 First St., Cambridge, Mass., will display in booth 38, its usual line of pop safety valves, relief valves, gages, whistles and similar equipment. The booth will be recognized by a large illuminated-dial Master Pilot gage, prominently displayed.

Atwood & Morrill Co., Salem, Mass., will display turbine and condenser valves, also special valves for low-pressure bleeder heating work and a new damper regulator. This will be in space 552-553.

Babbitt Steam Specialty Co., New Bedford, Mass., will be in booth 90. The feature of its display will be the adjustable sprocket rim to replace handwheels on valves in inaccessible locations with chain guide and chain running to an accessible point.

E. B. Badger & Sons Co., 75 Pitts St., Boston, Mass., will have in booth 436, its self-equalizing corrugated expansion joints, non-clog spray nozzles, multiple self-cleaning strainers for continuous operation, and other products showing its work as copper smiths.

Bailey Meter Co., E. 64th St. and Euclid Ave., Cleveland, O., will have a display of its equipment in space 54-55. This will include a number of new developments. One of the most interesting features will be the Bailey meter control for automatic boiler operation, in running operation to demonstrate its desirable features. A section of the new Bailey furnace wall will also be shown, designed to reduce the cost of furnace maintenance and permit operating at higher ratings. It is refractory lined and water cooled. Operation of a new pulverized coal feeder and meter to give uniform feed regardless of the

rate or moisture content will be demonstrated by a full-sized feeder.

The Ballwood Co., 30 Church St., New York, will have booth 249. Van Stone joints on wrought iron pipe, Van Stone flanged pipe and hammer-welded tongued and grooved flanged pipe, all for 600 lb. pressure will be included in its exhibit.

Barco Manufacturing Co., 1801 Winnemac Ave., Chicago, will be in booth 547. It will be exhibiting its Barco flexible joints for oil, steam, air, gasoline and other fluid pipe lines with ball male end working in special double gaskets. Also its lubricated plug valve which has the lubricant forced in and in which the valve stem has been eliminated.

Barnes & Jones, 5 Melrose St., Boston, Mass., will show in booth 313, appliances used in modern vapor and vacuum heating systems as adapted for any type of building. These will include modulation valves to permit radiators to be heated in whole or in part, thermostatic return traps to prevent steam passing from radiators to return lines, blast traps for units condensing large quantities of steam, condensators which insure that water of condensation is returned to the boiler regardless of pressure carried and other devices for efficient operation of heating systems.

Bartlett Hayward Co., Baltimore, Md., will be in space 344-345. A full line of standard shaft couplings will be on display, from No. 2 to No. 5 and some special couplings applicable to steel-mill service. Photographs will be shown of representative installations, detail drawings of various types of couplings and models illustrating their construction.

Bassick Mfg. Co., 2650 No. Crawford Ave., Chicago, Ill., will be found in Both 550 and will demonstrate an application of its Alemite forced grease lubricating system for machinery and shafting, the grease being applied under extremely high pressures so that it will be sure to reach the proper point of application.

The Bayer Co., 4067 Park Ave., St. Louis, Mo., will exhibit in booth 216. It will have a full line of mechanical soot blowers, with four models of heads for blowers of the revolving element type. One of these will be Model K, balanced valve-in-head, a complete high-temperature revolving element of double-tube, air-cooled, sectional type.

R. H. Beaumont Co., 319 Arch St., Philadelphia, Pa., will have its display in space 50-51. A miniature boiler house will be shown with coal and ash-handling machinery centralized including Beaumont skip hoist, coal weighing, larry and cable drag scraper, with full size winding machine used to operate the skip hoist. All details of the hoist will be in exact proportion to an actual installation. Elevation to bunker by the skip hoist, distribution by the larry and storage and reclaiming by the drag scraper will be illustrated, also the use of a tail block car. Another feature of the exhibit will be a full size, power-operated pivoted ash gate, two sections of the Beaumont sluicing system, a copper-steel ash hopper with hand-operated ash gate and an ash quencher, to spray water into the hopper, illustrating the collection of water by drains on the ash gates.

Bernitz Furnace Appliance Co., 80 Federal St., Boston, Mass., will have as usual, its various types of Super and Clinker-Proof blocks in booth 78. These blocks are specially adapted for furnace linings and, besides being clinker-proof, add to durability and decrease operating labor. As special features will be found a full size layout of an installation of Bernitz blocks and an interesting miniature model.

Bethlehem Shipbuilding Corp., Ltd., Bethlehem, Pa., will show full size machinery in space 70-71. The Bethlehem-Weir vertical, direct-acting feed pump, the turbine-driven feed pump, surface and open feed-water heater, surface condenser, Dahl oil burning system, heavy oil engine, evaporators, air compressors and de-aeration systems are among the products to be displayed and described.

Bethlehem Steel Co., Bethlehem, Pa., will occupy space 514-515-522-523. A full size Bethlehem pulverizer plant will be exhibited of roll tire type, with roller bearings protected from dust. This is designed for pulverizing, not only fuels, but any kind of mineral or granular material.

The Bigelow Co., New Haven, Conn., in booth 68, will demonstrate the various types of boilers which it builds. These will be of water-tube design as used for central stations and large industrial plants and of horizontal fire-tube and Bigelow two-pass type, a recent development, of special interest to the small industrial plant.

Bilton Machine Tool Co., Bridgeport, Conn., will have booth 442, where its line of automatic milling machines will be on exhibition.

Bird-Archer Co., 33 Rector St., New York, will have in booth 464, a demonstration of its boiler chemicals and system of adapting these to the conditions in individual plants.

Blackburn-Smith Corp., 25 W. 45th St., New York, will show in space 244-245, the operation of its automatic primer for centrifugal pumps. Also it will exhibit its multi-duct strainer, filter and grease extractor for purification of oil and of water. Strainer baskets may be cleaned without interrupting service.

Boig & Hill Co., 180 Washington St., New York, will have a display of Curtis steam specialties in booth 10.

Bolinders Co., Inc., 33 Rector St., New York, will exhibit in booth 481, its 6-7 b.h.p., 4-kw. oil-engine-driven generator set, which operates on heavy oil, has automatic force-feed lubrication and is fitted with ball bearings for shaft, cranks and regulator. Also will be shown the same engine direct connected to a centrifugal pump whose capacity is 330 to 350 gal. a min., depending on the total head.

Boston Gear Works Sales Co., Norfolk Downs, Mass., will have in 340-342, its new series of Standardized speed reduction units as well as Boston silent chain drives and hardened and ground-tooth spur gears.

Botfield Refractories Co., Swanson and Clymer Sts., Philadelphia, Pa., will exhibit in booth 567. Its display will consist of Adamant high-temperature fire brick cement for furnace construction and repair and illustrations of how it is used.

S. F. Bowser and Co., Ft. Wayne, Ind., will exhibit in booth 424. It will demonstrate its Bowser and Richardson Phenix systems for lubrication, oil filtration and oil storage showing operation of the complete systems. Representation, C. H. Bromley.

Bradley Washfountain Co., 2203 Sycamore St., Milwaukee, Wis., will demonstrate, in booth 247, the advantages of its equipment for plant washrooms.

The Bristol Co., Waterbury, Conn., will exhibit in booth 12. Its display will include a complete line of its recording pressure gages, draft gages, thermometers, pyrometers, psychrometers, and the like. Of special interest will be the new Bristol-Derr water level gage for steam boilers, which operates on the thermo-electric principle so that the indicating or recording instrument may be placed at a distance from the boiler in any convenient location.

Brown Hoisting Machinery Co., 4403 St. Clair Ave., Cleveland, O., will be in booth 450. Its coal handling systems for small and large plants with drop forged chain, apron conveyor, bucket elevator and pivoted bucket carrier will be illustrated by separate parts and models, also clamshell hoists, creeper and locomotive cranes, belt conveyors and electric hoists.

Brown Instrument Co., 4508 Wayne Ave., Philadelphia, Pa., will feature its electric CO_2 meter in booth 88. Gas is cooled, filtered and passed to a sealed cell and the conductivity, which varies with the per cent of CO_2, compared with that of air. Exhibit will also include indicating and recording thermometers, pressure gages and flue gas pyrometers in operation and a motor-operated damper control. Pyrometers will be of single, duplex and multiple control models with visible chart on which notations may be made. Two and three-pen recording thermometers will be shown and detail parts of all types of instruments.

Budd Grate Co., 2011 E. Hagert St., Philadelphia, Pa., will exhibit its new type stoker and its combustion arch system in booth 290.

Buffalo Steam Pump Co., Buffalo, N. Y., will exhibit in booth 73, a line of pumps and equipment for air handling and treatment. This will include the Buffalo Breezo-Tin unit heater, feed pumps, cooling fans, Carrier air washer and a special model of a fan for power plants.

Builders Iron Foundry, Providence, R. I., will have an exhibit in booth 277, showing uses of the Venturi meter for hot and cold water, liquid ammonia and other liquids. Part of the equipment will be in actual operation and detail parts of the meter and recording apparatus will be shown to demonstrate construction and action of these devices.

Bundy Steam Trap Co., Nashua, N. H., will exhibit in booth 8 its line of separating traps, boiler return and 3-valve lifting or vacuum traps. These will be hooked up to demonstrate actual working conditions as found in plants and will show the latest improvements and advances in steam trap construction.

Edwin Burhorn Co., 25 W. Broadway, New York, will be found in booth A, main floor. A model of a Burhorn Packers type cooling tower will be in operation demonstrating the rectification of water distribution at each deck by the trough deck system. Elimination of corrosion by the use of Matola metal will also be demonstrated. Pictures of recent installations will be displayed and operating costs shown.

Andrew C. Campbell, Inc., Bridgeport, Conn., will demonstrate its Nibbling machines in booth 440. The No. 1 belt-drive machine will be idle but No. 1B and No. 2 will be under power, motor-driven, and will be in action. No. 1B will cut $\frac{1}{16}$, $\frac{1}{8}$ and $\frac{3}{16}$-in. steel and No. 2, $\frac{3}{16}$, $\frac{1}{4}$, $\frac{5}{16}$ and $\frac{3}{8}$-in. steel. A

representative group of samples of work produced will be shown, also shapes will be cut free hand and to templates.

Carbondale Grate Bar Co., Scranton, Pa., will be found with a complete exhibit of its special grate construction in booth 448.

The Carborundum Co., Perth Amboy, N. J., will show in booth 22, by models and photographs, the advantages of Carbofrax refractories for over-rate, stoker-fired boilers. This will include standard brick and Bernitz air-cooled blocks. Also will be shown Carboplastic Gum for reducing maintenance cost of boiler settings and Carboradiant chambers which permit application of heat through carborundum by radiation.

Carling Turbine Blower Co., Worcester, Mass., will display in booth 17, its safety turbine and its supervane blower with detail parts to make clear the construction of both pieces of equipment.

Carr Fastener Co., 31 Ames St., Cambridge, Mass., manufacturers of the Dot high-pressure lubricating system which it will exhibit in booth 285. This system includes hand pressure guns, the large capacity hand compressor and tank, the electric compressor and tank, grease-gun fillers and Dot nipples and fittings both plain and with reservoir. The system has been adapted for all kinds of industrial machinery.

Carrick Engineering Co., 538 So. Clark St., Chicago, will exhibit in booth No. 264 its furnace regulators, chronometer valves and mercury-actuated master control. Of special interest will be a working model of the master control which will show in glass inclosures how the mercury column, which is used instead of springs or diaphragms, is balanced against steam pressure and the resulting regulation accomplished.

Carrier Engineering Corp., Newark, N. J., will have in booth 34 an exhibit of air conditioning equipment for heating and ventilating systems. Representative, W. H. Carrier.

A. W. Cash Co., Decatur, Ill., will exhibit in two booths, 28 and 276. In 28 will be found its complete Craig system of combustion control including the Type S master controller, actuated by steam pressure, for regulating the turbine-driven, forced-draft fans, the stoker engines and boiler up-take dampers. Automatic, furnace-pressure type regulators control the blast dampers at each stoker wind box. In 276 will be models of the complete line of pressure-regulating devices, several shown for the first time. Pressure and vacuum relief valves, remote-control regulators, pump governors, fan-engine regulators, strainers and special valves for ammonia systems will be included.

W. D. Cashin Co., 35 Hartford St., Boston, Mass., will exhibit in booth 568, valves, fittings and other heating specialties sold under the name Thermoflex.

Celite Products Co., 1135 Van Nuys Bldg., Los Angeles, Calif., will exhibit in booth 14, its Sil-O-Cel insulating products. These include insulating brick for temperatures up to 1600 deg. F. C-22 brick for use where temperatures behind the brick may run up to 2000 deg. F., powder for insulating steel-encased or hollow walls, plastic insulation, C-3 aggregate for insulating filling or for making insulating concrete, water-proofing and air-sealing compound for boiler walls and Fraxite high-temperature cement for laying and facing fire brick. Celite air insulating material for a mixture in concrete, Super-Cel and Filter-Cel for use as filter aids, will also be on display.

An interesting feature will be a demonstration furnace showing comparative heat flow through insulating and common brick walls.

Centrifix Corp., 830 Keith Bldg., Cleveland, O., will exhibit in space 564-565.

Centrifugal Fan Co., 180 Milk St., Boston, Mass., will have on display in booth 566 its exhaust fan system for ventilation and induced draft.

Chapman Valve Mfg. Co., 293 Hampshire St., Indian Orchard, Mass., will have a display of its valves in booth 2. A special feature will be fittings and valves of chrome-nickel steel which has a high tensile strength and is specially fitted for high pressures and temperatures. The remote control valves with red light signal for open, white when the mechanism is being operated and green when the valve is closed will be a special feature.

Cleveland Worm & Gear Co., 3249 E. 80th St., Cleveland, O., will have its exhibit in booth 92, showing its motor-driven, worm gear speed reducers.

Clipper Belt Lacer Co., Grand Rapids, Mich., will show in booth 337, four models of its belt lacers, all sizes of belt hooks including the Rustproof brand, belt cutters with safety feature in two models, and the rawhide and new special connecting pins. Notable in the exhibit will be the Clipper moving belt display, electrically operated and with all parts working on ball bearings so that the outfit is noiseless in operation.

Cochrane Corp., 17th St., below Allegheny Ave., Philadelphia, Pa., will have a working exhibit in booth 67. This will be a centrifugal pump circulating water through a V-notch meter, a pipe orifice meter and a new type filter. In this filter no strainers are used to prevent sand or gravel getting away, as the sand layer is above a gravel bed and water passes down through these, then up to a clear space and through an inverted metal cone. Velocities are such that no sand will be drawn up, even if it works down through the gravel, yet when backwashing, the filtering material will be properly distributed with the finest on top. The V-notch meter will measure the flow through the filter, recording and integrating it for any elapsed period. To the pipe-orifice meter will be connected three Cochran flow meters, one skeletonized and with glass mercury chambers to show the deflection caused by differential pressure from the two sides of the orifice. A second will have, besides the flow-recording pen, an additional pen to record pressure or temperature on the same chart. Other features of the exhibit will be a multi-port valve for back pressure service, steam traps,—one a multiport drainer for low pressures—and a separator sectioned to show internal construction.

FIG. 2. ALL THREE FLOORS WILL HAVE IMPORTANT AND INTERESTING EXHIBITS

Coen Co., Inc., 112 Market St., San Francisco, Calif., will show its oil burners, air registers, oil heaters and other devices for oil burning systems in booth 15B.

Coffin Valve Co., Tolman St., Boston, Mass., will show in booth 482, typical examples of its butterfly, check and foot valves.

Combustion Engineering Corp., 43 Broad St., New York, will have space 23-25. It will exhibit the C-E unit system for burning pulverized fuel, a No. 5 pulverizing unit with upper housing doors removed to show design and arrangement of the rotor, the hammers, fineness regulator and exhaust fan. The Lopulco pulverized fuel system will show a burner, a two-screw feeder, section of the air-cooled furnace wall and a working model of the Raymond pulverizing mill. In the C-E fin furnace exhibit, a section of furnace wall 8 or 10 tubes wide will be backed by the latest type of self-supporting wall. This will be of height to allow a view from above of the cross-section of the wall. Three full size elements of the C-E air heater will be shown. A most interesting feature will be a a Lopulco furnace and boiler with electrical effect of flame in

natural colors and in motion. Parts of various stokers, especially those revealing new features of design will be displayed and framed photographs and charts will give the results of pulverized coal plant performance.

Combustion Publishing Co., 11 Broadway, New York, will have in booth 53 an exhibit of its magazine Combustion and of its book department showing the latest books on combustion, from all publishers. A reception booth will be equipped for meeting old friends and making new ones who are engaged in handling combustion problems.

The D. Connelly Boiler Co., Ivanhoe Road and N. Y. C. & St. L. R. R., Cleveland, O., will have working models of its bent and straight tube boilers in booth 92. It will show also forged-steel sectional headers, adapted to 500 lb. pressure, and details of its boiler construction to demonstrate the advances in methods.

Connery & Co., 2nd St., above Erie, Philadelphia, Pa., will exhibit in booth 43, its improved expansion stiffener for breechings, air and preheater ducts; its air-cooled damper for use in breechings and hot air systems; also other equipment of like character for power plants.

William B. Connor, Inc., 223 W. 23rd St., New York, will exhibit in booths 346 and 347, the Ace Steam trap with seamless float and Corliss valve.

The Consolidated Safety Valve Co. Sales Department of Manning, Maxwell and Moore, Inc., 100 E. 42nd St., New York, will have in booth 60 a full line of Ashcroft gauges, Consolidated safety valves, Hancock valves, Metropolitan injectors and Tabor steam engine indicators.

Consolidation Coal Co., 67 Wall St., New York, will have samples of its product and illustration of the method of mining and preparation in booth 454.

Continental Valve & Equipment Co., 82 Herbert St., Framingham, Mass., will have a line of its forged steel fittings in booth 328. This will include box and flanged unions, and special designs for extra high pressures and temperatures. Another feature will be reducing valves and pump governors of an entirely new design.

The Cooling Tower Co., Inc., 15 John St., New York, will have in booth 532 a display of its cooling towers, spray nozzles, air washers and air filters. Sections of the Tank I Dust filter will show the construction of baffles and filtering media. Models and sections will show construction and operation of the cooling towers, also features of the Spirodrome nozzle to avoid clogging and freezing will be demonstrated.

Cored Bar Corp., 17 Battery Pl., New York, will show its product in booth 503.

Cork Foundation Co., 315 5th Ave., New York, will exhibit in booth 420. It will show its Absorbo material for use in setting all kinds of machinery in order to absorb vibration, made of strips of selected cork, set in steel frames and impregnated with creosote. Natural cork will be shown in various forms and two devices for testing vibration, as well as other operating machinery.

Chas. Cory & Son, Inc., 183 Varick St., New York, will be in space 241-242. The display will include Cory-Recony valve control units in five sizes for operations of valves 2 to 60 in. under any pressure and temperature conditions, showing operation with automatic gate obstruction control. Also the Cory audible and visible signal system and other apparatus for signal, control, communication and lighting requirements of central stations. Some of these will be, flow meters, sash and door operators, annunciators, turbine order signals, load indicators, water level indicators, relays, temperature and pressure alarms, lighting fixtures and wiring appliances.

Craig Damper Regulator Co., 701 Book Bldg., Detroit, Mich., will demonstrate its system of draft control for smoke elimination in booth 79.

Crane Co., 836 S. Michigan Ave., Chicago, will have booth 52 and will feature a typical boiler piping connection for a 400-lb. working pressure boiler. This will consist of a motor-operated stop and check valve, an electrically-tripped emergency stop valve and a motor-operated gate valve with various styles of pipe joints adapted to high-pressure service. Valves will be so connected that operation can be shown. In addition, samples of steel gate valves for pressures from 150 to 900 lb., also safety valves and relief valves will be exhibited.

Crane Packing Co., 1800 Cuyler Ave., Chicago, will exhibit full lines of metallic packing in booth 209. These are for steam, air, ammonia, hot oils and other liquids with special brands for superheat and high temperature work. Notable features will be the new Endless metallic condenser packing rings and the Extended condenser ferrule which are the latest development of the John Crane process.

Crankless Engine Co., 29 Broadway, New York, will have a complete exhibit of its product in spaces 402 and 403.

Crosby Steam Gage & Valve Co., 40 Central St., Boston, 8, Mass., will exhibit in space 302-303. Its display will include the Nickeloy globe valves, bronze, monel and steel valves, blow-off, safety and relief valves and a machine for testing gages up to pressures of 25,000 lb. per sq. in. The monel metal valves are designed for pressures up to 900 lb. and cast-steel valves are made for the same high-pressure service.

Cutler-Hammer Mfg. Co., 530 Grand Ave., Milwaukee, Wis., will have booth 16 and will show the Dean control units for operating valves by means of enclosed motors operated locally or with remote control. Also the Dean control for draft dampers and sash operation and the station load indicator.

The Dampney Co. of America, 50 Business St., Boston, 36, Mass., will have a display of protective coatings for metal surfaces in booth 248. These are the Apexior brand for use on water and steam surfaces of boilers, steel-tube economizers, air preheaters, coal bunkers, flues and piping. The method of application by means of power-operated equipment and of cleaning boiler tubes preparatory to application of the coating will be shown.

M. T. Davidson Co., 154 Nassau St., New York, will have a working model of its improved simplex reciprocating steam pump in space 36-37. This will demonstrate the action of the valve motion. Several types of full size centrifugal and reciprocating pumps will also be shown, opened so that the interior construction may be examined.

G. M. Davis Regulator Co., 422 Milwaukee Ave., Chicago, will have its exhibit in booth 494. This will consist of its line of piston-type and diaphragm-type pressure regulators, globe or angle float valves, globe or angle stop and check valves, back pressure and exhaust relief valves and Davis steam trap with double balanced valve.

Dearborn Chemical Co., 310 S. Michigan Ave., Chicago, in booth 13, will welcome its friends in a reception room having literature describing its methods of water treatment, lubricating oils and greases for power plants, No-Ox-Id rust preventive and other products. Samples of the products will be shown.

Julian d'Este Co., 26 Canal St., Boston, Mass., in booth 10, will exhibit stock sizes and section models of Curtis engineering specialties. A new device, exhibited for the first time, will be the Curtis domestic water regulator for small house requirements and process work. Other features will be the type C steam regulator with all parts renewable, including piston, lining and seat rings, without removing the valve body from the pipe line; damper regulators to be actuated by steam pressure or by hydraulic pressure; the Curtis traps, balanced steam, expansion and return types and the d'Este bucket trap.

The De Laval Separator Co., 165 Broadway, N. Y., will occupy the space 536 to 543 inclusive. In this space will be found the De Laval purifiers for cleaning fuel oil, transformer oil and used oil in machine shops. The fuel oil purifier, especially developed for purification of fuel oil for Diesel engines is made vapor-tight so that fumes cannot contribute to fire hazard. The transformer-oil purifier is a portable unit to clean oil used for insulation and cooling in transformers or oil circuit-breakers. It is made in standard type for ordinary transformers and in conservator type for the corresponding type of transformers.

De Laval Steam Turbine Co., Trenton, N. J., will have booth 536. Its exhibit will cover worm speed-reduction gears, helical gears, centrifugal pumps, steam turbines and compressors. Several pieces of apparatus will be connected in series, driven from a blast of air on a small fan impeller or by a small water turbine. Single and double-reduction units will be shown for both horizontal and vertical shafts and will be described in a special booklet. The turbine is of single pressure-shape type, designed for driving auxiliaries in capacities up to 1000 hp.

M. H. Detrick Co., 50 Church St., New York, will display small models of the Detrick flat suspended arch and its sectionally-supported sidewall in booth 94. The sidewall is a new feature of design, supported in sections, and has recently been used in a number of large pulverized fuel boiler settings.

Detroit Stoker Co., General Motors Bldg., Detroit, Mich., will have its display in space 204-206. It will show its underfeed, forced-draft, multiple retort stoker in operation, also its worm gear drive for stokers, with adjustment for controlling the stroke of the pusher rod by simply moving a pin in the adjustment block.

Detroit Twist Drill Co., 2108 Fort St. W., Detroit, Mich., will exhibit in booth 503.

The Diamond Power Specialty Co., Detroit, Mich., will have booth 16. It will exhibit Diamond Valv-in-Head soot blowers, Model G-2 soot blower, Model B, rear-end soot blower for return tubular boilers and patented barriers for protecting soot-blower units.

Walter S. Dickson & Co., 90 West St., New York, will be found in booth 232 with an exhibit of ventilating and heating specialties.

Joseph Dixon Crucible Co., Jersey City, N. J., will occupy booth 215. Attractive display will be found of its Ticonderoga flake graphite and other special quality graphites, and graphite greases, as well as silica-graphite paints and primers. Dixon's spring oil and rust solvent will have a prominent place and its use will be illustrated for automobiles, lawn mowers and other machinery of the household. Uses of silica-graphite and aluminum-graphite paints and of red lead-graphite primer in the power plant will be demonstrated.

F. W. Dodge Corp., 119 W. 40th St., New York, will have its exhibit in booth 27 of Sweets Catalog Service.

Donnelly Systems Co., 9 Murray St., New York, will have its display in booth 407. Steam control and distribution apparatus are the company's product, a feature at the show being the Donnelly control and reducing valve and the combination pressure and temperature recorder used in connection with this control. This device is to control the exact amount of steam used for domestic or industrial purposes, each installation having a special nozzle fitted for the specific job for which it is to be used. The recorder makes a history of outside temperature and nozzle pressure on the same chart and serves as a guide for regulating operating pressure to outside temperature.

Drake Non-Clinkering Furnace Block Co., 5 Beekman St., New York, will display in booth 41, samples of its blocks in Standard, Utility, S-X and Carbo-glaze types as used for furnace linings, bridge walls and kilns.

Durabla Manufacturing Co., 114 Liberty St., New York, will exhibit in space 500-501. Here will be found the Durabla line of power plant specialties, including sheet and rod packings, gaskets, gage glasses, valve discs and metal pump valves. Rod packings are of braided fibrous body with a metal facing strip of special construction on the inside surface to bear against the rod. One feature of the exhibit will be a specially built pump with glass-enclosed chambers to show action of the metal valves.

Eastern Steam Specialty Co., 242 Lafayette St., New York, will be in booth 12A.

Edge Moor Iron Co., Edge Moor, Del., will be in space 288-289. The main feature of the exhibit will be drawings, photographs and data explaining the construction and performance of the Edge Moor Single Pass boiler and the installation of this type at Binghamton (N. Y.) Light, Heat & Power Co.'s plant. Division into a large, steel-cased heater section, a steamer section and a superheater section will be shown with the interconnections and functions of each. Low draft loss, high temperature gradient and rapid heat transfer are features of the boiler action. Construction of horizontal boilers of longitudinal drum and cross-drum types will also be shown.

The Edward Valve & Mfg. Co., East Chicago, Ind., will feature in booth 30 its regular line of steel and monel metal valves in globe, angle, non-return, check and blowoff types for steam pressures of 300, 600 and 900 lb. per sq. in. A specially important item will be the Edward line of forged steel, flanged valves for 600 lb. steam pressure, in which the flanges are an integral part of the body forging.

Elliott Co., Jeannette, Pa., will be found in space 271-272-273-274. Its exhibit will be representative of its line of products and will include a small mechanical-drive Kerr turbine with details of buckets, packing and other parts. Also cut out models of single-stage, two-stage and combination ejectors, and of automatic cut-off and non-return valves, twin strainers and blow-off valves. Liberty and Lagonda boiler tube cleaners will be shown in representative sizes and types. There will also be a 500-gal. building type de-aerator for removal of air from feed water. It is expected that an air compressor will be in operation to furnish air for operating tube cleaners and ejectors, showing the flow of air through an ejector when in operation. Air will also be used in a combination type ejector to illustrate the use of an air-leakage meter which is connected to the ejector after condenser. Any models not in cut-out form will be opened up for inspection of interior parts and general construction.

Lewis M. Ellison, 214 W. Kinzie St., Chicago, will have booth 44B. In it will be found improved models of his draft gages, a new air filter gage with inclined scale and a new portable CO_2 gas analyzer made of Pyrex glass and monel metal. The filter gage shows resistance due to dirt stoppage and indicates the permissible resistance when the filter is in proper condition.

Charles Engelhard, Inc., 30 Church St., New York, will exhibit in booth 417. The display will consist of instruments for measuring electrically, temperatures and CO_2, the temperature measuring instruments including resistance thermometers of platinum-quartz type with Type S switchboard recorders for single and multiple record. These recorders are for use in connection with heaters, condensers, economizers and superheaters and may be arranged to give direct comparison of several temperatures on one chart. It will also be shown in portable type. The CO_2 instrument will be shown in a combination which records CO_2 and flue-gas temperature on the same chart.

The Engineer Co., 17 Battery Pl., New York, will show its three products in booth 18. A model will show the application of Turner baffle walls. Several motor-driven, combustion control regulators will be exhibited in operation; and a line of oil burners, registers and other specialties will be displayed.

Engineering Magazine Co., 120 W. 32nd St., New York, will meet its friends in booth 314.

The Engineers Book Shop, 126 E. 41st St., New York, will have a display of engineering books in booth 28-A.

Erie City Iron Works, Erie, Pa., will demonstrate its unit pulverizing and feeding system in space 217-218. It will also show the construction of its 3-drum water-tube boiler and illustrations of plants where its products have been installed.

Ernst & Co., Newark, N. J., will have, in booth 76, demonstration of the advantages of its water column with inclined gage glass, in which the water "shows red," its gage glass valves, and safety gage glasses.

Everlasting Valve Co., 1 Exchange Place, Jersey City, N. J., will display, in space 100-101, its line of Everlasting valves designed to withstand corrosive and erosive effects of fluids handled. Both Everlasting and Hotplug types will be shown. In addition will be a novel gate valve, the Looseat, specially designed to stay tight. For blowoff lines, the Tandem Model X combines two valves under one control.

Ex-Cell-O Tool & Mfg. Co., 1469 E. Grand Blvd., Detroit, Mich., will show its XLO bushings, grinding spindles and similar products in booth 442.

Fafnir Bearing Co., New Britain, Conn., will exhibit, in booth 246, a complete line of its industrial, wide inner ring bearings with self-locking collars as used for hanger and blower boxes and machine applications.

The line of standard bearings will also be shown, a stand of bearings being in operation. Its new hand book on ball-bearings will be distributed.

Fairbanks, Morse & Co., 900 S. Wabash Ave., Chicago, will have space 326-327 and 330-331. Here will be shown its centrifugal pumps, electric motors, piston pumps and the type Y Diesel engine. Ball bearings for pumps and motors and special features of design of the centrifugal pumps and the type Y engine will be found of particular interest.

The Falk Corpn., Milwaukee, Wis., will have an exhibit of its gears and couplings in space 338-339. One feature will be a two-plane type, double-reduction speed reducer, with herring-bone gears, giving speed ratios of 40-50 to 1, or 1150 to 23 r.p.m. and with 5 hp. capacity. This is especially designed for conveyor drive. Another feature will be the Falk-Bibby flexible coupling, joining a single-stage centrifugal pump to a driving motor which is mounted on a sliding base, pivoted at front and rear ends and thrown off center from side to side 6 deg. by means of an auxiliary motor.

Falls Engine Works, Sheboygan, Wis., will have its display in booth 17.

Federal Gauge Co., 25 Church St., New York, will have a display of indicating and recording types of gages for pressure and vacuum in booth 544. As a special feature, Mercoid switches will be displayed. In these an automatic motor control is actuated by change of temperature, pressure, vacuum or float and a current up to 10 amp. at 110 v. is made or broken within a sealed glass tube.

The Fisher Governor Co., Marshalltown, Iowa, will occupy space 35. It will feature pump governors, reducing valves, pressure regulators, lever and float valves and steam traps. Special attention will be given to the type 227A liquid level controller with supplementary devices for remote control.

Flexitallic Gasket Co., 924 N. 8th St., Camden, N. J., will be found in booth 408. It will erect there one of its gasket-making machines and demonstrate how Flexitallic is made. A full line of its gaskets for all purposes will also be shown.

Flexible Steel Lacing Co., 4607 Lexington St., Chicago, will display in booth 315 the full line of its products including Alligator steel belt lacing, Flexco and Flexco-lok lamp guards

and Flexco H. D. belt fasteners. The method of applying Alligator and Flexco H. D. lacings will be demonstrated and the lamp guards shown in actual use.

Flynn and Emrich Co., Holliday & Saratoga Sts., Baltimore, Md., will have in booth 46 a full mechanical Huber stoker which will be shown in a large size in actual handling of fuel. The method by which coking is accomplished before the fuel is fed onto the grates will be illustrated as well as the supply of secondary air to burn the volatiles. Also the action of the stoker bars in breaking up, distributing and feeding forward the coked fuel, with the means for control of fuel feed at any rate desired.

Foote Bros. Gear & Machine Co., 215 N. Curtis St., Chicago, will have on display in booth 556 its IXL worm and spur gear reducers in various types. A special feature will be a combination set consisting of a spur and worm gear reducer, giving a speed reduction of 3600 to 1. Another feature will be a motor in operation to demonstrate the reduction possible by combination sets, which may go as high as 50,000 to 1. A panel exhibit will show samples of the various types of industrial gears which the company manufactures, while photographs, literature and catalogs will illustrate and describe actual installations as well as the entire line of the company's product.

Foster Engineering Co., 109 Monroe St., Newark, N. J., will have a showing of its non-return valves, pressure-regulating valves and the Foster flexible joint in booth 84. The non-return valve is designed for use with steam at 400 lb. pressure and 800 deg. F. The flexible joint has a spring follow-up to keep it packed tight at all times.

The Foxboro Co., Inc., Foxboro, Mass., will display, in booth 62, its new Differential-Pressure type liquid level gage for boilers, indicating and recording gages for pressure and draft and indicating and recording thermometers.

The Frederick Iron & Steel Co., Frederick, Md., will have its exhibit in booth 465 . It will show different sizes and styles of centrifugal pumps, including a 2-inch., 3-stage type R for industrial service against moderate head, a 1-in. house pump with bank, in operation, driven by a gasoline engine and handling 35 g.p.m. against 30-ft. head; also a duplicate, direct-connected to electric motor and a double-suction, 1-stage pump. Model of a coal separator will be in operation as used in anthracite and bituminous fields for grading coal. An exhibit will be made of the Frederick rubber-bushed flexible coupling.

Fuels & Furnaces, 709 House Bldg., Pittsburgh, Pa., will be found in booth 561 ready to discuss combustion and furnace construction with those interested.

Fuller-Lehigh Co., Fullerton, Pa., will have a line of Fuller pulverized fuel apparatus in space 14A and 14B. This will include the single feeder, triplex feeder, vertical and horizontal burners, Fuller-Kinyon 4-in. pump for pulverized materials and pneumatic valve and bin-level indicator; also the Randolph vertical dryer. Special features will be a working model of the Fuller-Kinyon conveying system for pulverized materials, large photographs of installations and a display of moving pictures and lantern slides.

The Fulton Co., Knoxville, Tenn., will show its complete line of Sylphon apparatus in space 252-253. This will include Sylphon temperature regulators and pressure regulators as well as devices for special purposes. An interesting new feature will be a thermostatic water mixer which has been under development for 2 years. It takes hot and cold water at any degrees of temperature and mixes them to a definite outgoing temperature which may be adjusted to anything desired for washing or process work.

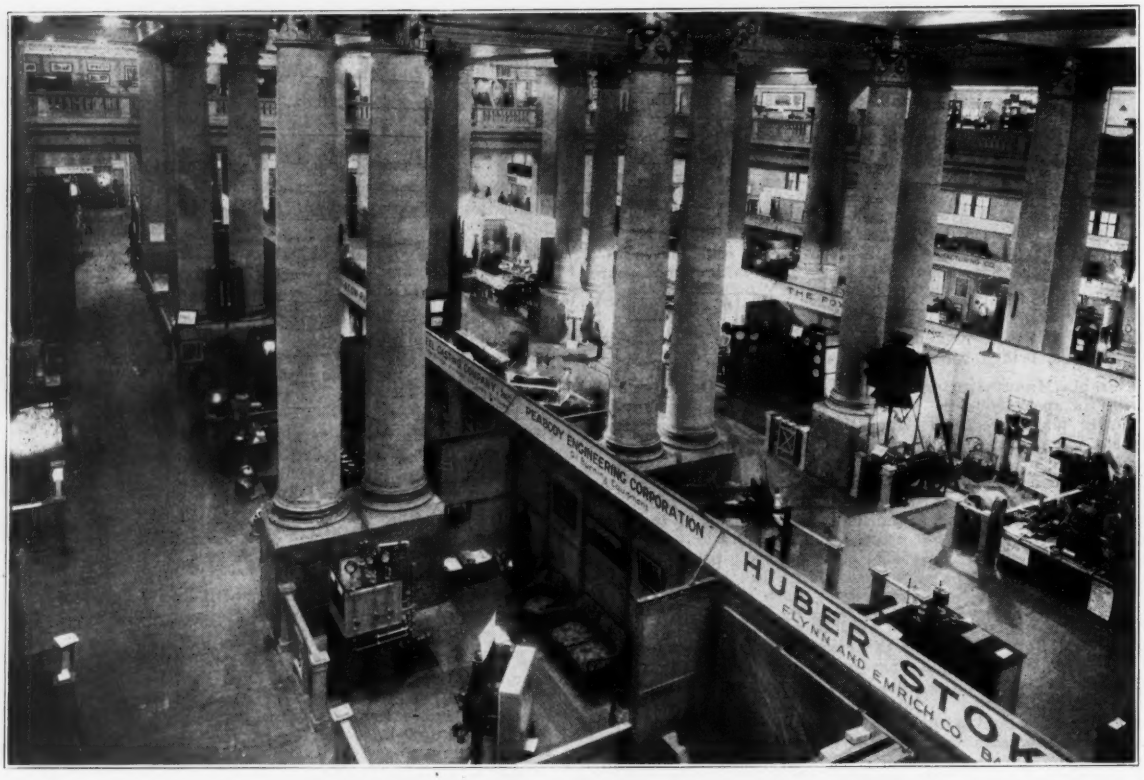


FIG. 3. MAIN AND MEZZANINE FLOORS FILLED WITH INTERESTING EXHIBITS

Furnace Engineering Co., Inc., 5 Beekman St., New York, will be found in booth 41. Its exhibit will be the Simplex unit pulverizer with revolving hammers, air separator and fan as made in capacities from 1500 to 15,000 lb. an hour.

• G. & G. Atlas Systems, Inc., 537 W. Broadway, New York, will have, in booth 15A, a pneumatic tube system as used for message and parcel carrying in department stores, banks, hotels and industrial plants, showing important improvements.

The Garlock Packing Co., Palmyra, N. Y., will show, in glass-enclosed and electrically-lighted mahogany cases at booth 505, samples of its various packings covering Garlock quality-controlled products and service. By means of a movie film, various processes of manufacture will be pictured, showing the methods of turning out these products.

General Electric Co., Schenectady, N. Y., will exhibit in space 4-5. The display will include flow meters, brush-shifting motors for alternating current, air cooler for turbo-generator ventilation and extensive motor and control equipment. The flow meters will be operated from steam generated in an electric boiler.

General Refractories Co., 117 So. 16th St., Philadelphia, Pa., will show its line of chrome and magnesite refractories and

fire-clay silica in standard and special shapes and sizes, in booth 498.

Gillis & Geoghegan, Inc., 537 W. Broadway, New York, will have, in space 87-88, two electrically-operated hoists, installed under conditions usually found in a building, showing their use for ash removal and the action of the safety devices. There will also be two hand-operated hoists for close-up inspection.

Girtanner Engineering Corp., 1400 Broadway, New York, will have, in booth 258, a display of its standard line of steam jet, vacuum and hydraulic pipe line conveyors, a special soot-handling apparatus and an exhibit of tile ash tanks. As a main feature, will be a miniature of a complete typical steam ash conveyor system, showing the pipe line in front of the boilers and discharging into a tile tank. It will be power operated, illustrating actual plant conditions as nearly as possible.

James T. Gordon Co., 50 Church St., New York, will occupy booth 92 with an exhibit of water and oil strainers, worm gear reduction units and Nicholson steam specialties.

A. P. Green Fire Brick Co., Mexico, Mo., will exhibit its Missouri flint clay brick and super-refractory brick in space 202-203. One of the features will be the Mizzou brand, made especially for severe temperatures such as are found in oil-burning furnaces; particularly severe strains are introduced from rapidly fluctuating temperatures and this brand is constructed to withstand such conditions.

Griscom-Russell Co., 90 West St., New York, will show expansion joints, Reilly evaporators, water heaters, multi-whirl oil coolers and U-fin generator air coolers, evaporators and Stratton steam and air separators in booth 49. A feature will be the G-R bent-tube evaporator with headers arranged vertically and rigidly held at top and bottom. This results in change of temperature, causing a slight bending of the tubes, sufficient to crack off scale which may have formed.

The H. & O. Chain Co., 83 Washington St., So. Norwalk, Conn., will show publicly for the first time, a new Universal coupling, in booth 10. It will be exhibited specially as a flexible cushion coupling, anti-friction but, by slight changes of small parts, it can be made into a universal coupling, a shock-resisting coupling, or adapted as a cushion coupling for heavy or for extra-heavy duty,—all in flexible form. It thus gives all combinations needed for transmission of power where two shafts meet, and will operate with an extraordinary amount of angularity between the shafts.

Hagan Corporation, Pittsburgh, Pa., will occupy the same space, booth 21, as heretofore. A working model will show the application of the Hagan system of Compensated Draft, using small induced and forced draft fans in connection with a model furnace to reproduce conditions that actually exist in plant operation. This will demonstrate the response of the regulating equipment to changes in steam pressure, load, furnace draft or fuel bed thickness and will be a most interesting study. A working exhibit of a full-sized steam purifier will show its principle and demonstrate the completeness with which it removes moisture and impurities from steam leaving the boiler. In addition will be displayed a complete line of equipment developed as a result of co-operative agreement between the Hagan Corp'n and the U. S. Bureau of Mines over a period of 4 years. This has placed on a definite footing the mechanism of scale formation in boilers and means for preventing it. Engineers will be in attendance to explain applications of Hagan equipment for pressure reduction, de-superheating and proportioning of gas and air for gas firing.

Hahn Engineering Co., 20th St. and Indiana Ave., Philadelphia, Pa., will have two groups in its exhibit in space 404-405. The first will feature conveyors and parts, such as elbows, rebound fittings, nozzles and renewable liners with inserts of electric corundum which have proved to have excellent wearing qualities. In the second group will be tanks and bunkers, cast-iron sectional units of octagonal and semi-octagonal design, equipped with thawing steam chambers, splash stars and agitators.

Hand Stoker Corp., 21 Park Row, New York will be in booth 46 with an exhibit of Huber stokers.

Hanson, Whitney and Co., and Hancon Tap & Gauge Co., 169 Bartholomew Ave., Hartford, Conn., will have their exhibit in booth 557.

Hardinge Co., Inc., 120 Broadway, New York, will have a display of its conical mills in booth 329.

The Jos. W. Hays Corp., Michigan City, Ind., will exhibit in booths 81-82 its line of fuel-saving devices, including draft gages, flue gas analyzer, automatic gas collector and automatic CO_2 and draft recorder. The last named will be the simplified and improved Model B, using the Orsat principle and provided with soot filter and venturi-type aspirator.

Heine Boiler Co., 5319 Marcus Ave., St. Louis, Mo., will have space 496-497 for a display of its V-type boilers and of the long-drum, cross-drum and bent tube types. Illustrations of details of construction and photographs of notable installations will complete the exhibit.

Hendrick Mfg. Co., Carbondale, Pa., will show its perforated metal screens, elevator buckets, Mitco Shur-Site stair treads and its Mitco steel gratings in booth 471.

E. Vernon Hill Co., 64 W. Randolph St., Chicago, will feature in booth 510 its portable pitot tube outfit with gage and accessories complete in carrying case; also air instrument sets in compact form for convenient carrying in the pocket or in hand cases where a complete set of instruments is desired. These will include pitot tubes, multiplying manometers, draft gages, anemometers, whirling psychrometers, comfort thermometers, etc.

The M. A. Hofft Co., 814 W. Washington Ave., Indianapolis, Ind., will exhibit, in booth 502, a National flat suspended arch in which any tile may be replaced while the furnace is in operation, the weight of each tile being carried by a separate hook. Also will be shown a National hand-operated stoker for 150-hp. plant, this being combined with the flat arch into an illustrative furnace and setting.

Hollow Ball Co., Baltimore, Md., will show in space 558-563 its seamless balls of steel, aluminum, copper, brass and monel metal in sizes from ¼ in. to 3 in. diameter. It will illustrate many of the uses of these balls as floats and valves and the process of forming them.

Homestead Valve Mfg. Co., Homestead, Pa., will exhibit in booth 428. Here will be found a complete line of its valves, one interesting feature being a model showing the effect of fluid passing through an ordinary globe valve and also passing through one with protected seat construction, by means of a sectioned valve with plate glass insert. The Protected Seat operating valve with balancing feature to permit easy operation will be shown, also the Homestead lubricated quarter-turn valve, which carries lubricant under pressure on all working surfaces. Other features will be a complete line of valves in brass, semi-steel and cast steel, combination blowoff valves and 3-way and 4-way quarter-turn valves.

James Howden & Co., of America, Inc., 25 Broadway, New York, (Air Preheater Corp.), will have its exhibit in space 234-235. It will show the Ljungstrom air preheater, Howden compressors and forced draft apparatus, also its patent furnace fronts.

The Paul B. Huyette Co., 5 So. 18th St., Philadelphia, Pa., in space 81 and 82, will have in actual operation the latest type of Hays CO_2 and draft recorder, a General Electric, electrically-operated steam flow meter connected to a column of water so as to illustrate correctly the effects of increased and decreased steam flow on the electrical records. There will also be shown the Ajacks damper regulator and control valve, Reliance safety water columns, PBH chain-operated water gages and weighted gage cocks, Reliance pressureless alarms and other engine and boiler room appliances.

The Hydraulic Press Mfg. Co., 227 Fulton St., New York, will have, in its booth 551, an H-P-M motor-operated automatic control valve for hydraulic pressure systems. Also a panel showing types of its Forsteel fittings and valves, the latter a new design with straightway body and inclined valve adapted for high-pressure superheat work. Another panel will carry types of H-P-M hydraulic valves used in operating hydraulic presses.

Ilg Electric Ventilating Co., 2850 No. Crawford Ave., Chicago, will display, in booth 533, its apparatus, fans, motors and control equipment, for ventilation of shops and large buildings.

Illinois Engineering Co., Racine Ave. and 21st St., Chicago, will exhibit a complete line of steam and heating system specialties in booth 233. This will include cut samples of valves for pressure reduction and back pressure control, steam traps, thermostatic radiator trap, and equipment for vapor heating systems. A glass model steam trap will be shown in operation to demonstrate the valve action and a vapor system to show the action of the heat retainer.

Industrial Management Group, 120 W. 32nd St., New York, will display, in booth 314, its publications, Industrial Management and Industry Illustrated.

Industrial Power, 440 So. Dearborn St., Chicago, will be in booth 39.

Insulating Products Corp., 280 Madison Ave., New York, will have an exhibit of materials for preventing loss of heat from steam systems in its booth 437.

International Filter Co., 333 W. 25th Pl., Chicago, will show, in booth 221, its hot-flow softener, cold-process type J softener for smaller plants, type V for larger plants, Zeolite softener and its filters using sand and cotton fiber disks.

The International Nickel Co., 67 Wall St., New York, will show, in booth 9, commercial forms of monel metal in rods, sheets, castings and ingots, as well as machined parts made from the metal. These will include stems, seats and discs for valves, plungers and rods for pumps, gaskets, bolt, nuts and washers.

In the moving picture program, reels will show the mining, refining and rolling of monel metal from ore to warehouse.

International Trade Press, Inc., 15 Park Row, New York, will be found in booth 444, where its publications, Belting, Transmission Tools & Supplies—Cement, Mill & Quarry—Engineering World and American Machine & Tool Record, will be found.

Irving Iron Works Co., 320 Creek St. and Dutchkills Creek, Long Island City, N. Y., will have in its space, 438-439, its Subway open steel flooring and its Safsteps for use in power plants. The Subway flooring is so made as to be non-slipping, even when it has water, oil or grease on it, so that it can be walked, wheeled or worked upon at all times with ease. Use of Subway flooring and Safsteps is in the line of safety insurance against accident.

Jenkins Bros., 80 White St., New York, will display its valves, arranged as in actual use, in booth 90. They will have glass port holes so that the flow of fluid, as the valves are opened and closed, can be studied. Among the types shown will be the swing check, Y blowoff, gate, cross, angle, rapid action and horizontal check. Regrinding valves, hard bronze valves for superheat, automatic stop and check valves for boiler outlets and air guns for all purposes will be featured. Jenkins Bros.' sheet packings and rubber pump valves will also be displayed.

Manistee Iron Works, Manistee, Michigan, will have in booth 562 a full line of its Roturbo pumps for all services.

Johns-Manville, Inc., 292 Madison Ave., New York, will be found in space 508-509. Asbestos and allied products for conservation of heat and power will constitute the exhibit. Included will be roofing and building materials, pipe covering and insulation, packings and power specialties, asbestos textiles, asbestos wood and other specialties.

W. A. Jones Foundry & Machine Co., 393 7th Ave., New York, will specialize its exhibit, in booth 549, on spur and worm gear speed reducers and miscellaneous power transmission equipment, including the Lemley friction clutch, keyless compression coupling, safety set collar and flexible coupling.

E. Keeler Co., Williamsport, Pa., will have in booth 211, a "live" exhibit consisting of several glass model boilers in operation to demonstrate what takes place in boilers. This will be fully described by engineers at the booth who will give a continuous talk, explaining why action in boilers is as it is.

M. W. Kellogg Co., 90 West St., New York, will feature forge and hammer welded tongue and groove pipe ends with swivel flanges. These will be in booth 72, also the same type flanges welded directly to pipe, a hammer-welded nozzle forge-welded to pipe, copper-plated forged pipe and the Kellogg radial brick for chimney construction.

Key Boiler Equipment Co., East St. Louis, Mo., will have its display in booth 426. It will show safety hand hole caps for water tube boilers, flange joints for high pressure piping and graphite paste for sealing and securing thread and gasket joints. Representatives, Fred Key, V. P., and George W. Coleman.

Keystone Lubricating Co., Philadelphia, Pa., will have, in booth 8a, a display of its lubricators, cups and greases in solid and liquid form, also high-temperature greases. A feature will be a working model of the Keystone safety system of grease lubrication. This will consist of a line shaft and crank motion with crosshead, all bearings being lubricated by the system. Wristpin and slides are connected by grease-proof hose to the main feed pipe. The system will be in operation.

Keystone Refractories Co., 120 Liberty St., New York, will show, in booth 11, its Key-Cel-Brix, a calcined insulating brick of high crushing strength and low shrinkage, also Dura-stix, a binder for refractory construction, and Steel Veneer, a refractory construction, used for facing new fire-brick settings.

Kieley & Mueller, Inc., 34 West 13th St., New York, will be located in booth 480, where will be found its specialties, such as steam traps, float valves, pressure-reducing valves, water columns and back-pressure valves. A special feature will be the new improved Kieley bucket trap and ball float continuous discharge trap.

King Refractories Co., 705 Greenwich St., New York, will occupy booth 95. Features of the exhibit will be Mono boiler baffling and high-temperature cements; also the Flame brand of high-temperature cements in several grades to meet the various requirements of furnace construction.

Kingsford Foundry and Machine Works, Oswego, N. Y., will have in booth 425 an interesting display of its Kingsford-Webster sectional water tube boilers in cross drum and longitudinal drum types showing the views of steeply inclined straight tubes and equalized connections to give continuous supply of water to the lower tube rolls.

Kissick-Fenno Co., 1201 Chestnut St., Philadelphia, will be in booth 19 with a display of Vulcan soot cleaners and Copes feed-water regulators.

John W. Kittredge, 350 So. Blvd., Atlanta, Ga., will show his 2-speed chain hoist in booth 453. This is designed so that the load pull on the lifting line throws into slow-speed, preventing lowering of load at fast speed, but allowing fast lowering when load is off. It will not lift an overload, but will hold an overload until the chain breaks.

Klingerit, Inc., 16 Hudson St., New York, will have in booth 317 the Klingerit piston valves which have neither seat nor stuffing box, but pack directly on the plunger. They are made suitable for all liquids, steam and gases. Another feature will be a high-pressure asbestos valve disc, suitable for Jenkins Bros. and similar valves, and which has shown remarkable durability. Klingerit Reflex water gages and high-pressure asbestos sheet packing will form part of the exhibit.

The George T. Ladd Co., First National Bank Bldg., Pittsburgh, Pa., will be located in booth 91 where will be displayed photographs, prints and operating data, showing the construction, installation and performance of its water-tube boilers. General information on boiler characteristics and operation will also be available. The company's new catalog No. 23, now in course of publication, will be distributed.

Lead-Lined Iron Pipe Co., Wakefield, Mass., will have a display of its pipe for handling corrosive liquids in booth 86. Samples of the pipe and of methods of making joints to avoid corrosion will be exhibited.

The Libbey Glass Mfg. Co., Toledo, O., will occupy booth 416 with a display of its products. This will include high-pressure and standard gage glasses, red line glasses, reflex glasses, bull's-eye type lubricator glasses and oil cup glasses. The special feature will be the high-pressure glasses, for pressures up to 400 lb., which are tested by hot oil bath and cold water plunge, by steam erosion and by hydraulic pressure. The Libbey Klinger reflex glass is corrugated to indicate water level clearly and is subjected to optical test for shadow, heat test for spalling and breakage, and tests for erosion and clouding.

Liberty Electric Corp'n, Stamford, Conn., will have in its booth, 435, two motor-operated valves, one with control through manual switches, the other with push-button relay control. The exhibit will be arranged to make clear to operating men what combinations of control stations can be used in wiring up the Liberty valve operator units and will give opportunity to try out control with the different switch stations. A cut-away model will show the internal details and working of the unit and its safety clutch which protects the valve stem, if foreign matter gets into the gate of the valve.

Liptak Fire-Brick Arch Co., Mexico, Mo., will have, in booth 201, the Liptak products. These will include a single suspension arch, a double suspension arch and solid and air-cooled furnace walls. The details of construction of each type will be fully shown in the exhibit and advantages explained by the company's booklets.

Locke Regulator Co., 767 North St., Salem, Mass., will display its damper regulators in booth 307. These are for control of the heaviest as well as the smallest dampers and are so adjusted as to respond promptly to slight changes in steam pressure.

Ludeman Brothers, 165 Broadway, New York, will exhibit its L-B system of safety stops for steam engines, turbines, pressure lines and vessels, designed to prevent wrecks, due to flooding with water. Application to a number of systems will be illustrated. The display will be in booth 516.

The Lunkenheimer Co., Cincinnati, O., will have booth 63. Its exhibit will include a 16-in. cast-steel, electrically-operated gate valve for 400 lb. pressure, 6-in. sectioned cast-steel gate, globe and check valves for 400 lb. or greater pressure, a 2½-in. cast-steel blowoff valve for 600 lb. pressure, 6-in. iron body, bronze-mounted gate valves, groups of small valves—all monel gate, cast-steel globe and check, Ferrenemo globe, bronze-regrinding and Renewo globe, check, gate and quick-opening in bronze and bronze stop cocks. Fusible plugs, extra-heavy regrinding automatic water gage, rough and finished valve parts will also be shown. The special features will be the high-pressure valves for service up to 900 lb., the iron body, bronze-mounted line and photographs of installations and of plant facilities for manufacture.

McDonald & Co., 88 Washington St., New York, will have its display in booth 449.

McLeod & Henry Co., Troy, N. Y., will occupy booth 13. In this lucky space will be shown a line of refractories for boiler settings, including Steel Mixture boiler door arches with jambs, back combustion chamber arches, fire-box lining blocks, blow-off pipe protectors, high-temperature cement, standard firebrick, standard and special tiles and baffles. As special features will be flat suspended arches and air-cooled walls in working models to illustrate the ease of installation, repair and replacement of sections and units of the arches and the readiness of use of the walls with old settings as well as with new. Air intake, circulation and use of the preheated air will be demonstrated.

W. B. McVicker Co., 295 Douglass St., Brooklyn, N. Y., will demonstrate in booth 323 its system for analyzing and prescribing treatment for boiler feed waters, with individual attention to steam users.

Manning, Maxwell & Moore, Inc., 100 E. 42nd St., New York, will have its display in booth 60A. This will include four Reeves variable speed transmissions of latest design; one of remote electrical control type; one for automatic mechanical control with complete ball bearings; one compact unit motor individual transmission, fitted with steel link V belt; and one standard, hand-controlled transmission. This transmission is a variable-speed countershaft with range from 2 to 1 up to 16 to 1 and for handling 1 to 150 hp.

Manufacturers Record, Baltimore, Md., will display in booth 40 photographs and data regarding steam and hydro-electric plants in the South as well as statistics and information covering the sixteen southern states.

Marion Machine, Foundry & Supply Co., Marion, Ind., will show its type C hand stoker in booth 210. It will feature also soot blowers for water-tube and fire-tube boilers with balanced head and quick-opening valve, and a furnace observing device which enables the fireman to watch the condition of gases passing through the boiler, without leaving the firing aisle.

Marlin-Rockwell Corp., 4527 Palmer St., Chicago, will display in its space, 336-343, Strom ball bearings, including the new Super-Strom. By means of four panels, the production of a bearing will be illustrated from raw stock to finished product, with photographs of various factory operations. As a moving exhibit, the rotor of a turbo-generator will be kept revolving on ball bearings, by means of the air from a small electric fan. Comparative friction will be demonstrated by a stand with two shafts, each lifting a 200-lb. weight, one having plain bearings, the other ball bearings. A crank on each shaft will enable visitors to test the frictional resistances.

Mason Regulator Co., Dorchester Center, Mass., will have space 223-224. In this it will show a complete line of pressure regulators, including reducing valves, pump governors of pressure and of speed-control types; fan and stoker engine regulators and hydraulic damper regulator, balanced and float valves; standard bronze and iron-body valves; high-pressure, cast-steel valves. The damper regulator and pump speed governor will be shown in operation as under actual working conditions.

Merco-Nordstrom Valve Co., Inc., 110 W. 40th St., New York, is a subsidiary of The Merrill Co. of San Francisco. In booth 267 will be exhibited all types of its Lubricated Plug valves. Of special interest will be a 16-in. valve of the plug-cock type, believed to be the largest of this type ever manufactured. There will also be shown semi-steel valves and lubricated valves in Duriron, Knight chemical stoneware, aluminum-bronze and other alloys suitable for chemical work.

Merrick Scale Mfg. Co., Passaic, N. J., will have a full size Merrick Conveyor Weightometer in its space, 237-240. This device weighs and records the weight of material as it is being conveyed and is adapted for weighing incoming coal into storage or bunkers.

L. R. Merritt Co., 250 Park Ave., New York, will be in booths 31-32 with full line of the equipment and specialties which it represents.

Metalastic, Inc., 90 Montgomery St., Jersey City, N. J., will demonstrate, in booth 408, the qualities of its plastic packing for rod and shaft, stuffing boxes. This can be removed and reused as required and is intended for service under all temperatures from refrigerating to super-heated steam and for high as well as low pressures.

Metallo Gasket Co., 242 Lafayette St., New York, will have, in booth 12-A, an exhibit of its Metallo gaskets; of corrugated copper, asbestos-filled, for flange joints, suitable for high-pressure and superheated steam lines; of double-jacketed, corrugated steel, asbestos-filled, for oil refineries; manhole gaskets with single jacket of corrugated steel, asbestos filled, for high-pressure boilers; Bethany cylinder gaskets of double-jacketed copper, asbestos filled for combustion engines and air compressors; monel metal gaskets, plain corrugated and with asbestos filler for superheated steam; steel-asbestos tube cap gaskets for Heine and B. & W. boilers. Also will be shown valve discs of asbestos entirely cased in copper for use in Jenkins Bros. and similar valves.

Metropolitan Brass Founders Association, 97 2nd St., Brooklyn, N. Y., will show its variety of products in space 477-478. These will be special castings in brass, bronze and aluminum from members of the association.

Midwest Piping and Supply Co., 1450 S. 2nd St., St. Louis, Mo., will exhibit in booth 268, its pipe joints, welded headers and examples of difficult pipe bending. Midwest joints, with ball and socket action and requiring no gaskets, will be shown as used between pipes, from pipe to fitting or valve and between fittings and valves. These are especially adapted for high pressures and temperatures. Sargol and Van Stone joints as made by the Midwest Co., will also be shown.

FIG. 4. LARGE EQUIPMENT WILL BE FOUND IN FULL SIZE IN MANY SPACES

Moore Steam Turbine Corp., Wellsville, Ky., will have, in booth 433, an exhibit of its centrifugal pumps and steam turbines, also parts of each to show design and construction. The pumps, which have not been exhibited before, will be shown in single and multi-stage types.

Morse Chain Co., Ithaca, N. Y., in space 262-263, will have on display numerous applications of its silent chain drives, showing the rocker joint feature which gives operating efficiency of 98.6 per cent. Examples of installations will be shown which operate at speeds of 250 to 6000 r.p.m., and for powers from ¼ to 5000 hp. on centers as short as 24 in.

Morse Dry Dock & Repair Co., Foot of 54th St., Brooklyn, N. Y., will occupy space 300-301-304-305, where working models will be displayed of its oil-burning equipment. As nearly as possible, various types of boilers will be shown in operation with oil burners, using wood walls for furnaces with glass side walls to give clear view and spraying in water to represent the oil spray, illuminated to a reddish tint so as to give a realistic reproduction of an oil-fired furnace. A new feature will be conical and fan-tail oil and gas burners of both steam and air-atomizing types.

The Moto-Meter Co., Inc., Long Island City, N. Y., will have an exhibit, in booth 254, consisting of industrial thermom-

eters suitable for temperatures from —40 deg. to +750 deg. F. Also special instruments for transformer work and for use on automobiles, motor boats and airplanes.

Mueller Mfg. Co., Ltd., Port Huron, Mich., will have its exhibit of brass and copper products in space 554-555.

Nash Engineering Co., So. Norwalk, Conn., will show Jennings Hytor vacuum and condensation pumps for removing air gases and condensate from heating systems. Also circulating pumps for hot water and condenser systems, in booth 66. The Hytor sewage ejector, with no relief valve, will also be a feature.

The National Acme Co., Cleveland, O., will exhibit in booth 521. It will display various lines of screw machines, an especial feature being one of its latest type 5-spindle automatic screw machines to work 1-in. bar. The positive positioning and locking of tools, ease of tool installation and safety devices will be worthy of study.

National Co., Inc., Cambridge, Mass., will be in booth 76, where it will exhibit its Water Column Illuminator which throws light on the glass from opposite sides so that the level may be read even at a distance as great as 40 ft. above the boiler room floor.

National Engineer, 417 So. Dearborn St., Chicago, will greet its friends in space 83.

National Lead Co., 111 Broadway, New York, will give, in booth 517, a continuous demonstration of the installation of cinch bolt anchors. It will have an exhibit of cinch bolts and Dutch Boy babbitt metals and will distribute literature on these products.

National Tube Co., Frick Bldg., Pittsburgh, Pa., will show in booth 8B, Shelby seamless tubing, boiler tubes, welding scale-free pipe and Vanstone flanges.

Naugatuck Mfg. Co., Naugatuck, Conn., will have, in booth 447 a complete line of its seamless copper-ball floats for receivers, tanks, steam traps, water columns, and regulators, which are tested to 300 lb. pressure. These floats are made in all shapes and styles. The exhibit will also include pump air chambers.

Neemes Foundry, Inc., 206 1st St., Troy, N. Y., will have in booth 93, an exhibit of full sized models of grates, the Superior dumping grate for cheaper grades of anthracite and the Neemes Improved shaking and dumping grates for coal which tends to form clinkers. A special form of side bar to adjust for width of furnace and device for locking grate bars in place are features of these grates. The shaking and dumping grate will be motor-operated to show the rocking action of the shakers.

W. H. Nicholson & Co., Wilkes-Barre, Pa., will have as a main feature, in booth 92, a Nicholson piston-operated trap, with glass sides making the action, as it operates, visible. Sectional models of its weight-operated steam trap, its expansion steam trap and its four-way controlling valves will also be displayed.

Niles-Bement-Pond Co., 111 Broadway, New York, will occupy space 526-529. Its exhibit will be made up of samples of Maag gears, including spur, helical, herringbone, spiral and ground spur gears as well as gear reduction units.

The Nitrose Co., Peoria Life Bldg., Peoria, Ill., will exhibit, in booth 484, its paint for resisting acid and moisture and withstanding hard wear and the effects of extreme heat and cold.

Norma-Hoffmann Bearings Corp., Stamford, Conn., will exhibit in space 279-280 a complete line of Norma open and closed type ball bearings and of Hoffmann ball, roller and thrust bearings. Several models illustrating the features of various types of bearings will be shown and a new device to illustrate their friction-free running. The Norma Minimeter for measuring bearing parts to extremely close limits will also be displayed.

Northern Equipment Co., Erie, Pa., will have in booth 19 various sizes and types of its Copes line of control valves, pump governors, valve movement indicators and feed water regulators. As a principal feature a Copes boiler feed water regulator will be shown in operation, illustrating the relation between boiler load, water level and control of feed water input so that by giving a definite feed valve opening for a given water level, when steam demand falls off, the level is raised so as to store heat and at peak load, the rate of feed is temporarily cut down so that the boiler can make steam at a maximum rate.

Norton Co., Worcester, Mass., will be found in space 324-325. Included in the exhibit will be a full line of its refractories such as brick, rectangular plates and tile, tubes, baffles, muffles, cores and cements. These materials are specially developed for the heavier duty required with high operating temperatures and the burning of low-grade fuels. They are made of alumina, silicon carbide, magnesia and mullite, the trade names Alundum and Crystolon being well known for the company's electrically fused alumina and silicon carbide, both of which are used in the refractories. Typical shapes and samples of raw material will be shown.

S. Obermayer Co., Jefferson & Thomas Sts., Newark, N. J., will be in booth 260 and exhibit a complete line of refractory materials.

Tinius Olsen Testing Machine Co., 500 N. 12th St., Philadelphia, Pa., will have booth 227. There will be demonstrated its up-to-date testing and balancing machine equipment, including its latest automatic and autographic testing machine of 50,000 lb. capacity, with gear box giving eight speeds in either direction and giving autographic record for tension, compression or transverse tests right up to rupture. Also its hydraulic machine for Brinell hardness tests, equipment for determining ductility or drawing quality of sheet metal, hardness testers of dead weight and of pendulum type will be shown with strain gages, extensometers and other small apparatus. For balancing, will be demonstrated, the Olsen-Carmen static-dynamic machine and the Olsen-Lundgren vertical spindle type of flywheel balancing machine.

Orange Bearing Co., Orange, N. J., will have in its booth 228 a full line of industrial roller bearings, including taper, thrust and annular types. The Hart staggered bearing for industrial use will be shown, also larger type bearings as used by the U. S. Navy, the steel companies and others demanding bearings of large dimensions.

Otis Elevator Co., 260 11th Ave., New York, will show the details of its elevator construction and control and its elevator repair and replacement outfits in booth 57. Also its skip-hoist controller for boiler room and blast furnace plants.

Paulsen-Spence & Co., 25 Church St., New York, will have in booth 28, Sterling traps, Craig combustion control system, and water softening system.

Peabody Engineering Corp., 110 E. 42nd St., New York, will be in booth 47 and will have an exhibit of its oil burning equipment for boilers. A feature will be the wide range mechanical burner with bypass, for regulating from banked fire to maximum load without change of burner tip.

Pennsylvania Crusher Co., Stephen Girard Bldg., Philadelphia, Pa., will have as a main feature of its exhibit, in space 286-287, a working model of a Bradford coal breaker and cleaner and another of an Armorframe single-roll crusher. A large number of photographs will show the specialized line of crushing machinery which will be described by trade literature.

Perfection Grate & Supply Co., Springfield, Mass., will show its shaking and dumping grates and special grate bar construction in booth 258.

The Permutit Co., 440 Fourth Ave., New York, N. Y., will be in booth 3 where it will display a model of water-softening and filtering equipment as used in industrial plants. This will be made to exact scale from the design of a large commercial unit that delivers 100,000 gal. a day, with every detail complete in miniature, and will present a striking and clever piece of workmanship. Also will be exhibited the Ranarex combustion indicator which indicates the percentage CO_2 in flue gas by purely mechanical means. Literature will describe and illustrate the application of both slow and rapid zeolite water softeners for large and small plants.

Perolin Co. of America, 1112 W. 37th St., Chicago, will have booth 506. Here will be shown the Formet and Perolin systems of treating water and boiler metal to prevent formation of scale and adhesion to boiler surfaces. Also a line of double service blowoff valves which automatically regrind and adjust the disc to seat at each opening and closing.

Philadelphia Gear Works, 1120 Vine St., Philadelphia, will show, in booth 10, its industrial gears of all types for all purposes and its speed-reducing units. Special features will be Fabroil, rawhide and Micarta pinions and Diamond chains for sprocket drive.

Pittsburgh Testing Laboratory, Locust & Stevenson Sts., Pittsburgh, Pa., will have a demonstration of its facilities and methods for testing and inspection of all kinds of materials including coal, cement, metals and machinery. It will be located in booth 91. An Attract-O-Scope will be used to show photographs of its work and in part of what the service consists.

Pittsburgh Valve, Foundry & Construction Co., Pittsburgh, Pa., will exhibit, in booth 4, its standard line of high-pressure piping and valves for all purposes.

Plibrico Jointless Firebrick Co., 1130 Clay St., Chicago, will exhibit in booth 93 a complete furnace model with front door arch and side walls built of its firebrick and demonstrating the advantages of a monolithic furnace lining.

The Wm. Powell Co., Cincinnati, O., will show in booth 495 a complete line of its iron, brass and steel White Star valves, also valves of monel metal and with monel metal trimmings. Lubricators, whistles, grease cups and a complete line of fittings for gasoline pump manufacturers will be on display.

Power Plant Engineering, 537 S. Dearborn St., Chicago, in booth 98, will extend to friends its greetings and will have a space where visitors may rest and read. Display panels will illustrate notable features of important modern power plants.

Power, 10th Ave. and 36th St., New York, will have its display in booth 42.

Power Specialty Co., 111 Broadway, New York, will show the Radiant type superheater with forged steel elements, in booth 20. Construction and application of this equipment will be illustrated, also for the Foster convection-type superheater and the Foster economizer.

Pratt & Cady Co., Bridgeport, Conn., will have its steel valves and fittings in booth 48, also bronze and iron body valves in globe, gate and check form. One of the steel valves will be motor operated.

Pratt & Whitney Co., Hartford, Conn., will have space 526-527 and will exhibit its 16-in. model B lathe, the 6-in. model B vertical shaper, both under power and operated by expert demonstrators who will show the full capabilities of the machines. There will also be a large showcase displaying a complete line of small tools and gages and a pair of circular plates bored with extreme accuracy, a standard test of the company's jig borer.

Preferred Utilities Co., 33 W. 60th St., New York, N. Y., in space 219-20, will have a line of the products made by W. S. Ray Mfg. Co. of San Francisco. These are rotary fuel oil burners of various types, with automatic control, electric drive or manual control, steam turbine drive for firing power boilers—with automatic control for commercial heating boilers, also for domestic heating boilers. This burner is of the mechanical atomizing type, requiring heating of heavy fuel oils only to a point where it can be pumped, about 100 deg. F. at 25 to 50 lb. pressure.

Production Machine Co., Greenfield, Mass., will have its exhibit in booth 452.

Public Service Products Co., Newark, N. J., will have an extensive exhibit of its products in spaces 462 and 463.

Pyramid Iron Products Co., 136 Liberty St., New York, will be in booth 306.

Queen's Run Refractories Co., Inc., Lock Haven, Pa., will be found in booth 569. An exhibit will be arranged of the Q. R. Glass brand of fire brick, especially adapted for boiler purposes. Its use will be illustrated and specimens of special shapes will be on display.

Quigley Furnace Specialties Co., 26 Cortlandt St., New York, will display, in booth 89, its line of refractories. This includes Hytempite for laying up fire brick and furnace construction and repairs; Ganisand used with Hytempite for lining and repairing furnaces; Carbosand for conditions where a highly refractory material is needed; Mono-line, ready-to-use for lining foundry and steel furnaces; Pyro-mortar, specially prepared for construction of furnaces for unusually high temperatures; Insulating brick for boiler settings, furnaces and kilns; Acid-proof cement for bonding and surfacing acid-resisting refractories; triple A solutions for protecting iron, steel and other materials from rust and corrosion and for protecting and decorating surfaces of concrete, brick and stone; the refractory gun for shooting pre-mixed refractories at high velocity against a wall or arch in construction and maintenance work.

Racine Tool & Machine Co., Racine, Wisc., will show, in booth 3, its line of Racine high-speed metal cutting machines, including a 4-in. capacity junior portable type, motor-driven; a 6 by 6-in. high speed machine, motor-driven; and duplex band saws with two-speed transmission.

Ramsey Chain Co., Inc., 1031 Broadway, Albany, N. Y., will have, in space 292-293, an exhibit of its silent chain drives with roller bearing and compensating joint chain.

Raymond Bros. Impact Pulverizer Co., 1319 No. Branch St., Chicago, will have an exhibit, in booth 24, of its pulverizing machinery, equipped with air separation, for reducing any material to a powdered condition.

Reading Steel Casting Co., Bridgeport, Conn., will show, in booth 48, typical valves of its line such as Reading steel gate and globe valves, Pratt & Cady brass and iron body valves and asbestos-packed cocks; also a complete exhibit of the new A. E. S. C. class fittings. A feature will be a motor-operated steel valve of the Series 40 class and others in smaller sizes and different classes. An addition recently made to the Pratt & Cady line will be union bonnet bronze globe valves, with nickel-bronze seats and discs, made for 200-lb. and for 300-lb. pressure rating.

Reed Air Filter Co., 211 Central Ave., Louisville, Ky., will show, in booth 316, the details of its all-metal filters and what they accomplish in delivering clean air in ventilating systems.

Reeves Pulley Co., Columbus, Ind., will be in booth 60-A, where will be found its variable speed transmission equipment with models showing the construction, action and accurate variation of speed to be obtained by this system over a wide continuous range.

The Reliance Gauge Column Co., 5902 Carnegie Ave., Cleveland, O., will have its exhibit in booth 81. It will display its regular safety water column and its forged steel safety water column, for high-pressure service, equipped with nickel alloy seats and discs and nickel floats of seamless construction. Also will be shown an electric alarm and safety device for cutting out an oil burner in case of low water in the boiler. Seamless solid shell floats will be a feature, produced with no seams, soldering or welding.

Ren Mfg. Co., 768 Main St., Winchester, Mass., will have, in booth 415, a display of Ren-Locks, which are an effective lock to prevent theft of electric light bulbs. The device is attached by means of a special punch and, after locking, the bulb can be removed only by breaking the glass, for which purpose a special bag is provided.

Republic Flow Meters Co., 2240 Diversey Parkway, Chicago, will occupy booth 6, where will be found its entire line of Republic instruments. This will include meters for steam flow, boiler performance, water, coal, air and gas, CO_2 recorders, draft indicators and recorders, pyrometers, and liquid level indicators and recorders. New devices will be the motor-driven CO_2 recorder, which eliminates difficulties due to dirty water and carries 90-days supply of KOH; multiple draft indicator, having all readings on one eye-level and permanent zero setting; electrical liquid level indicator for distant reading and record of levels in reservoirs and tanks, and without moving parts.

Richardson Scale Co., Clifton, N. J., will have a miniature power plant in space 283-284, using three boilers, to show the use of coal-weighing apparatus. One boiler will have its automatic coal scale, weighing coal continuously from overhead bunker to stoker down-spout, the weighing and operation of the stoker grate being in actual synchronous operation. On a second boiler the scale will weigh crushed coal from overhead storage to the pulverizer, also a working model. The third boiler will have a working model of a hand-weighing larry for weighing from overhead bunker to stoker hoppers. All models will represent Richardson actual products in every detail.

Riley Stoker Corp., Worcester, Mass., will have a full size Riley Atritor, the first public showing of this unit pulverizer, in space 79. Another feature of its exhibit will be a complete new mechanical-drive Jones side-dump stoker. Descriptive literature of its Riley, Murphy and Jones stokers will be available for visitors.

The Roberts Steam Specialty Co., 5318 St. Clair Ave., Cleveland, O., will have a line of steam specialties in booth 548. This will consist of safety water columns with high and low water alarms, seamless copper floats, all-welded float for extreme pressures, laminated steel floats, nickel processed, the Gage-Lite for water gages, the A. & D. steam flue cleaner, Diamond weighted-lever gage cocks and water gages. Of special interest will be the welded steel floats for high-pressures and superheat conditions and the new weighted-lever gage cock with position of the lever quickly adjustable on the stem.

John P. Robinson, 110 W. 34th St., New York, will exhibit in booth 278.

Rollway Bearing Co., Lacrosse, Wisconsin, will exhibit its products in booth 409.

The Roto Co., Hartford, Conn., will have, in booth 11-A, its devices for cleaning boiler tubes, economizers, surface condensers, evaporators, boiler hand-hole seats and hand-hole caps. The tube cleaners are mechanically driven by air, water or steam and work conveniently in straight or curved tubes of all sizes. Hand-hole seat cleaners are hand or power operated and cap cleaning machines are adapted for either oval or round caps.

Ruggles-Coles Engineering Co., 120 Broadway, New York, will exhibit its drying equipment for coal and other materials in booth 329.

Ruggles-Klingemann Mfg. Co., Salem, Mass., will occupy space 559-560 with a display of steam specialties. These will include the R-K water-seal trap, a boiler feed line pump governor sectioned to show construction, a sectioned single seated balance lever valve, a sectioned adjustable chronometer valve, an R-K step-action, fan-engine or damper regulator, a compensating, type A temperature control regulator, an 8-in. spring-loaded relief valve, an R-K motor-operated valve and an R-K motor-operated excess pressure regulator mounted on a General Electric Co. control panel.

Ruths Accumulator Corp., Ltd., Johns-Manville Bldg., New York, will have booth 491 for a display of a model of the Ruths steam accumulator and A. V. A. pressure regulating valves. The combination of these devices provides a system applicable to any plant which carries a fluctuating boiler load, giving constant load on the boilers, thus increasing capacity and eliminating peaks, also increasing efficiency of operation of the boiler plant and the production equipment in the factory.

Sarco Co. Inc., Woolworth Bldg., New York, will show at booth 33 its thermostatic control apparatus, steam traps and appliances for steam heating systems. A special feature will be its new No. 9 self-adjusting steam trap. This trap is designed on the balanced pressure principle. The pressure within the thermostatic or motor element balancing against the steam pressure so that the trap is self-adjusting over the entire range from 0 to 100 lb. All its thermostatic appliances use the special Sarco tubing or bellows with the seamless bronze tubing corrugated in helical or spiral form.

The S-C Regulator Mfg. Co., Fostoria, O., will feature feed water regulators and pump governors in booth 318. Improvements will be shown in standard regulators for pressures under 400 lb. and developments made during the past year in high-pressure regulators for 400 to 600 lb. pressure. High-pressure pump governors for systems carrying 650 to 700 lb. will also be shown. A new design, the result of 5 yr. experience, will be exhibited in drainage control equipment for all working conditions. Another exhibit will be the S-C Master control for reducing control of valves, pressures and boiler room equipment to handle special conditions.

Scandia Mfg. Co., 103 Mechanic St., Newark, N. J., will have its display in booth 432.

Schutte & Koerting Co., Philadelphia, Pa., will display, in its space 545-546, a high-pressure, toggle-top, non-return valve, a high-pressure, offset-body, trip throttle valve and a motor-operated, non-scraping gate valve. Another feature will be a multi-jet condenser and miniature spray cooling system, both in operation. Balance of the exhibit will be a sectional oil cooler, small valves and jets and material descriptive of the oval Radiafin tubes used for generator air coolers.

Scovill Manufacturing Co., Waterbury, Conn., will exhibit a comprehensive line of its products. Displayed in booth 69 will be brass, bronze and nickel silver sheet, rod, wire and tubing, parts for radio, electrical apparatus, automobiles, gas fixtures, toilet articles and buttons. High-speed brass rod for use in automatics at unusually fast operation will be featured. Also cup-drawn Admiralty condenser tubing which has been through various tests, illustration of the process of manufacture in different stages and a metallurgical microscope for showing the structure of good tubes and those which have failed by corrosion or cracking.

Seminole Chemical Co., 75 Vesey St., New York, will have its exhibit in space 256-257.

The Sharples Specialty Co., 2314 Westmoreland St., Philadelphia, Pa., will be in booth 26 with a display of its centrifugal purifiers for lubricating, switch and transformer oils, which are stated to recondition even badly carbonized and sludged oils to satisfactory dielectric condition.

Simplex Oil Heating Co., 1199 Eddy St., Providence, R. I., will exhibit its system in booth 492.

Simplex Valve & Meter Co., 112 N. Broad St., Philadelphia, Pa., will have, in booth 76, a display of three steps in metering; first, an indicating floor stand type manometer; second, an indicator recording meter; third, an indicating, recording and totalizing meter. These meters, of venturi type, are designed to meet any demand from simple indication to a complete record of water used for feed water to boilers, condensate, circulating water or industrial supply, either cold or hot.

FIG. 5. EXHIBITS ARE PLANNED AND DISPLAYED FOR COMFORT AND INSTRUCTION OF VISITORS

S-K-F Industries, Inc., 165 Broadway, New York, will occupy space 332-333. Its exhibit will include all types of ball bearings for all purposes covering radial and thrust types, double row, self-aligning bearings with balls and with rollers, ball-bearing hangers, post hangers and pillow blocks and chrome alloy steel balls.

D. H. Skeen and Co., 53 W. Jackson Blvd., Chicago, in booth C, will have an exhibit of Mercon regulators and governors for boiler feed and pump control and Mercon valves for relief, pressure regulation and reduction. Of especial interest will be the cut-away models showing the construction without stuffing boxes, weights, springs or packing to give extreme delicacy of action.

Skinner Bros. Mfg. Co., Inc., Elizabeth, N. J., will feature, in its space 321-322, its Improved steam coil air heater, New Improved light-weight copper tube air heater, Patented Direct fired heater for oil burning, and Revolving Door oven for japanning, enameling and lacquering.

M. B. Skinner Co., 558 Washington Blvd., Chicago, will display in booth 431 its full line of clamps for pipe, pipe joints, pipe lines and collar leaks, also pipe benders and reseating tools for valves and bibb cocks. A large pipe with clamps in position as if in use will give a graphic demonstration of the use of the clamps for pipe repairs.

F. L. Smidth & Co., 50 Church St., New York, will be found in booth 281. Its exhibit will demonstrate the advantages of the Lenix, short-center belt drive by means of a working model showing the power lost through belt slippage, using the stroboscopic method.

Smith & Serrell, Globe Indemnity Bldg., Newark, N. J., will have its display of couplings in booth 85. Improved couplings will be shown in a full line. Flanges in smaller sizes will be of steel, with maximum bore capacity increased 15 to 20 per cent. Couplings will be of all-metal designed to give great power capacity, long life, low investment and maintenance costs, large and easy endwise extensibility and, in the larger sizes, inherent lubrication.

Smoot Engineering Corp., 136 Liberty St., New York, will have, in space 418-419, as a main exhibit, an installation of Smoot control, mechanical regulation of boiler operation in actual service. A master regulator furnishes a central point from which all elements of combustion are controlled. Steam pressure variations, actuating the controller, regulate the fuel quantity, air volume and draft. The apparatus will be shown full size as installed in large plants, but the boiler and auxiliaries will be models to meet space conditions. Other features will be regulators of various types—the suction for coke ovens, low-pressure for gas and air and generator air cooler control.

Southern Engineer, Grant Bldg., Atlanta, Ga., will display its publications in booth 10.

W. K. Sowdon, 280 Madison Ave., New York, will be found in booth 76 with an exhibit of products of the Simplex Valve & Meter Co., Williams Gauge Co., Ernst & Co., and the National Separator & Machine Co.

Speednut Wrench Corp., 50 Church St., New York, will demonstrate, in booth 443, the advantages of its line of wrenches and tools for rapid turning out of work.

Spray Engineering Co., 60 High St., Boston, Mass., will demonstrate, in booth 469, the action of its spray nozzles, strainers, flow meters, air coolers, washers and filters, of paint guns and of spray ponds using its equipment.

Springfield Boiler Co., Springfield, Ill., will show, in space 31-32, various parts of its water-tube boiler and, as a special feature, a working model of the boiler. There will also be a complete model of the Hell Gate station of the United Electric Light and Power Co. of New York City, in which Springfield boilers are installed.

Stack Heater Co., 69 Sudbury St., Boston, will have a full display of its equipment in booth 312.

Standard Steel and Bearings, Inc., Plainville, Conn., will feature in booth 343, its ball bearings, both finished and in various stages of production. SRB balls made of Molybdenum steel, such as used in armor plate, to give toughness and high breaking strength and hardness will be on display. An interesting demonstration will be a ball gauging apparatus to show the speed at which steel balls can be sorted to variations of 0.0001 in. in diameter.

Standard Water System Co., Hampton, N. J., will show, in booth 28, its system of feed-water treatment to remove impurities and scale-forming material.

Steacey-Schmidt Mfg. Co., York, Pa., will be in booth 329 with an exhibit of its steam specialties.

Sterling Engine Co., 1252 Niagara St., Buffalo, N. Y., will exhibit in booth 518. A high-duty gasoline engine, rated 225 hp. at 1200 r.p.m., will be shown. This is the company's latest development for driving pumps, electric generators or other units, in either regular or standby service. Its features are six cylinders, replaceable cylinder sleeves, 7-bearing, counterweighted crank shaft, dual valves, overhead cam-shaft, vacuum fuel supply, safeguard against backfiring and high-pressure lubricating system.

Sterling Engineering & Mfg. Corp., Hyde Park, Boston, Mass., will have its lifting trap in operation in booth 28, as a main feature. Other traps and detail parts will complete the display.

Stewart-Sayres Co., Inc., 50 Church St., New York, will be in booth 26 with an exhibit of oil purifying apparatus.

B. F. Sturtevant Co., Hyde Park, Boston, Mass., will occupy space 411-414 with an exhibit of its fans, blowers, turbines, motors, engines, stokers, economizers and air-preheaters. A latest design, high-speed fan for forced draft will be direct-connected to a steam turbine. Silent fan for ventilation will be direct-driven by electric motor, drawing air through an air washer as used for ventilation or for generator cooling. Other features will be a turbo-undergrate blower for forced draft, fan for induced draft, motor-driven propeller fan for ventilation and a steam engine. Economizer tubes will be shown of the lead-coated steel type to withstand high pressure and corrosion, also of extended surface type with steel discs so tightly attached that indentation shows on the inside of the tube. Air heater sections will be shown of plate type, the individual sections being easily replaceable and easily cleaned. Cindervane fans are especially adapted for removing 75 to 90 per cent of the solid matter from flue gases. The Silentvane fan is of the type to be used in ventilating the new vehicle tunnel joining New York City with New Jersey.

Sumet Corp., Buffalo, N. Y., will exhibit its products in booth 427.

Superheater Co., 17 E. 42nd St., New York will have a display of Elesco superheater units, models and parts in booth 56. Construction of the forged return bends and ball joints will be demonstrated and superheater installation shown by photographs and lantern views of plants which the company has supplied with its product.

Swartwout Co., 18,511 Euclid Ave., Cleveland, O., will have space 229-230. Its low-pressure, float steam trap, with large valve opening, air separator for removing moisture from air lines, and its return lifting and vacuum traps will be displayed. The principle of separation used in Swartwout products will be demonstrated in action. Exhaust heads, ventilators and feed-water heaters will also be shown in the exhibit.

Sweets Catalogue Service, 119 W. 40th St., New York, will be found in booth 27. Here will be shown a poster exhibit giving brief description of the service.

C. J. Tagliabue Mfg. Co., 18 33rd St., Brooklyn, N. Y., will show in booth 59 the fully compensated TAG-Mercury recording thermometer having the TAG spiral spring seasoned to give permanent elasticity and resilience. The inverted, non-corrodible pen arm has a fixed pivot and adjustments for pen pressure, and lateral position. Bulb and capillary tube are a single piece, welded and give uniform chart graduations for all ranges. Other instruments of the TAG line are dial indicating thermometers, mercury thermometers with red reading column, automatic controllers for temperature and pressure; oil testing instruments, including colorimeter, and Saybolt viscosimeter; hydrometers and clinical thermometers.

Taylor Instrument Cos., Rochester, N. Y., will show in booth 507 a complete line of its instruments for power plants. This includes Industrial, Index (Dial Type) and Recording thermometers for temperatures of feed water, economizers, condensers, steam, flue gases and oil lines; self-acting and air-operated temperature controls for de-superheaters, bleeder lines and storage tanks; indicating and recording thermo-electric pyrometers for furnace and flue-gas temperatures; engraved stem testing thermometers; aneroid and mercurial barometers; mercury-column vacuum and absolute pressure gages. A feature will be a mercury column vacuum gage of precision type arranged with vernier to read to 1/100 in. which is so designed that when used with mercurial barometer the errors cancel out. An improved type of base metal recording pyrometer will also be shown.

Techno-Service Corp., 46 W. 40th St., New York, will exhibit in space 265-266 two large models of Borsig valves, with electric control designed for definite and reliable closing by a disc moved to and from the seat by a toggle joint mechanism. When open, the disc is swung into a recess in the bonnet, leaving a clear passage through the valve body. Valves are designed for 450 lb. pressure and 750 deg. F. The Kobra pump for handling sludge or ashes will also be exhibited.

Templeton, Kenly & Co., Ltd., 1020 S. Central Ave., Chicago, Ill., will have a display of its Simplex jacks in booth 504.

Templeton Mfg. Co., 115 Business St., Boston, Mass., will be in booth 28 with the Sterling Engineering and Manufacturing Co.

The Terry Steam Turbine Co., Hartford, Conn., will include in its exhibit, space 421 and 422, its steam turbines, reduction gears and flexible shaft couplings. Notable as a feature will be a steam turbine of the latest type with casing raised so that the interior construction can be fully studied.

Thomas Flexible Coupling Co., Warren, Pa., will display its product in booth 222.

The Henry G. Thompson & Son Co., New Haven, Conn., will have in booth 350 its line of metal cutting saws and metal sawing machinery. Its Mil Flex brand of hack saw blade is made with wavy set and soft back of tungsten steel especially for cutting pipe, BX, sheets, conduit and like material.

Tidewater Oil Sales Co., 11 Broadway, New York, will be found in booth 95A, showing samples of its lubricants in each of the various stages of production and a chart of the steps in refining oil and manufacturing petroleum products. Oils for lubrication, for combustion and for medicinal purposes will be included.

Timken Roller Bearing Co., Canton, Ohio, will show in booth 466 the application of its bearings to power plant machinery and to shaft hangers and other transmission equipment. It will illustrate also the saving in power over the use of plain bearings by the use of roller bearing equipment.

The Toledo Pipe Threading Machine Co., Toledo, O., will have its exhibits in booth 499. Special features will be its power drive pipe machine No. 1000, for cutting, threading and reaming pipe from ½-in. to 2-in. The Toledo power drive which is a 1½-hp. motor, mounted on wheels and carrying 20 ft. of flexible cable to operate hand threading and cutting tools; this will be shown in operation with tools up to 12-in. The Toledo portable work bench on which pipe up to 4-in. can be cut and threaded. Also a full line of pipe tools for hand operation.

Topping Bros., Varick and Vandam Sts., New York, will have a display in space 503-504 of Cored Bar products, Detroit twist drills and Torchweld welding equipment and Simplex jacks.

Torchweld Equipment Co., Fulton and Carpenter Sts., Chicago, will demonstrate its equipment and methods of welding in booth 503.

The Trane Co., La Crosse, Wis., will have on display in booth 472 a two-motor return line special vacuum pump in operation and a complete line of its heating specialties including 14-corrugation bellow radiator traps and bellows-packless supply valves. The pumps have separate case construction and the traps and valves are made with seamless bellows.

Trill Indicator Co., 34 E. South St., Corry, Pa., will exhibit in booth 429 its continuous card indicators for both open and closed diagrams; single-card indicators and the Corry check valve. The features of this valve, which give it extra long life, will be a feature specially demonstrated.

Triplex Machine Tool Co., 50 Church St., New York, will exhibit its line of shop equipment in booth 441. This will include Ames lathes and milling machines, Dumore grinders, Bilton automatic milling machines, Campbell nibbling machines and XLO jig bushings.

Uehling Instrument Co., 473 Getty Ave., Paterson, N. J., will have among the power plant instruments which it expects to exhibit at the Power Show in booth 45, the Waste Meter for continuously measuring and recording the fuel wasted up the chimney. This instrument records the percentage of CO_2 and temperature of the escaping flue gases on one chart. One especially important advantage of having both CO_2 and temperature on the same chart is that the engineer is thus enabled to determine whether special efforts were made to increase the CO_2 during heavy load periods, when fuel consumption is accelerated and when the stack temperature naturally rises. The pyrometer record shows when the soot was blown, when scale was removed from the boiler and also indicates by-passing of the gases due to leaky or broken-down baffles. Another important instrument to be exhibited is the Uehling combined barometer and vacuum recorder, which is in reality an automatic log of steam turbine performance.

Union Iron Works, Erie, Pa., will make an especially attractive display in booth 519. The booth will be handsomely decorated and enlarged photographs will show installations, patented details and special features of the Union Water-Tube boilers and the Union Universal boilers with literature giving full descriptions of construction and operation.

Vastine Sales Corp., 205 W. Harrison St., Chicago, in booth No. 520, will show its furnace fire observer, a device to be inserted in the door or side wall of the furnace so that the boiler operator may, at all times, observe the condition of the fire and brickwork without letting cold air into the furnace or permitting escape of heat. An air-cooled casing with a glass front accomplishes the result and gives such clear view that photographs of furnace conditions can be made if desired.

Vincent-Gilson Engineering Co., Inc., 30 Church St., New York, will have booth 17 with a display of soot-blowers, engine stops and turbine blowers of the companies which it represents.

Henry Vogt Machine Co., 10th and Ormsby Sts., Louisville, Ky., will have space 269-270 in which will be found a complete line of drop-forged steel valves and fittings for steam, or for hydraulic pressures up to 10,000 lb. per sq. in. on fittings and to 6000 lb. for valves.

Vulcan Radiator Co., Hartford, Conn., will be found in booth 406.

Vulcan Soot Cleaner Co., Du Bois, Pa., in booth 19 will show the latest developments in its soot cleaners, particularly its self-contained, Vulcan, valve-operating head, its improved ratchet operating head and its high-temperature, heat-resisting soot cleaner elements. The valve is an integral part of the Valve operating head, avoiding necessity of independent valves in the riser pipe. The valve is a swinging disc, self-grinding, positive in action and, together with the rotatable element, operated by one handle or chain. In the ratchet head rotation must be in a step-by-step movement through a mechanical escapement, avoiding spinning of the element.

Wailes-Dove-Hermiston Corp., 17 Battery Pl., New York, will have its exhibit in space 261-262. As features will be the materials and method for lining coal and ash bunkers with tile and its Bitumastic and Hermastic paints and enamels for preventing corrosion of metal surfaces.

Waite Davey & Co., Inc., Long Island City, N. Y., will have its product on exhibit in booth 255, showing suspended arches, air-cooled side wall blocks and rear combustion arches. Air passing through the side walls reaches as high as 500 deg. F. temperature.

Walsh & Weidner Boiler Co., Chattanooga, Tenn., will be found in space 250-251. It will exhibit seamless, forged-steel, sectional headers used in its water-tube boilers and will illustrate other constructional features by detail parts, drawings, photographs and models.

Walworth Co., Boston, Mass., will show as a principal material its products of Sigma steel, including valves and fittings. These will be in spaces 308-311 and 44-A. An item of interest will be a 4-in. steel fitting for 400 lb. working pressure, which was heated at 2500 lb. hydrostatic pressure, then fitted between two 10-ft. lengths of pipe which were supported on 18-ft. centers and loaded with a weight of 7248 lb. giving deflection of 27⅛ in. when the fitting touched the floor. The load and pipe were removed and the fitting examined but no effect could be discovered except slight stretching of the lower wall and compression of the upper wall, faces of the ends being 0.96-in. out of parallel. The display will also include iron body and brass gate and globe valves, Walworth tools, Kewanee unions, piping and X-Ray views of Sigma steel sections.

Warren Steam Pump Co., Warren, Mass., will occupy space 231. Here will be found the Warren steam-driven, reciprocating and centrifugal pumps, with detail parts to illustrate the construction and operation, and the Hickman air separator for eliminating air from feed water.

Warren Webster & Co., Camden, N. J., will use space 225-226 and will have as one of the principal points of interest the opportunity to learn what occurs inside the piping of a steam heating system. Research engineers and service men will be available to discuss any question, scientific or practical, concerning heating. The main feature of the exhibit will be a working model of a Webster type R modulation system of steam heating with all essential features visible under glass. This will show the function of each item of the system, boiler return trap, vent trap and valve, modulation supply valves, and Sylphon traps, with other specialized appliances.

Watts Regulator Co., 250 Lowell St., Lawrence, Mass., will display in its booth 309, a sample board showing its line of steam specialties. Watts flow charts will be distributed, showing the steam capacity per hour for Watts reducing valves and curve charts showing the flow through various sizes of pipes. These enable purchasers to select valves of correct size for the service required so as to avoid unnecessary expense for too large a valve and avoid wire-drawing with the consequent wear and upkeep cost.

Wayne Tank and Pump Co., Fort Wayne, Ind., will have its display in booth 99. Included will be a nickel-plated working model of a double unit industrial water softener, a household water softener, a one-barrel capacity lubricating oil pump and a model 364-C oil pump. The working model will be complete and accurate in every detail and will present clearly the mechanical features of the Wayne softener. Booklets will explain the advantages of water softening in the power plant and how to get "Permanently Clean Boilers."

Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., will have in space 487-490 an extensive display of steam turbines, air ejectors, circuit breakers and articles made from micarta, a material whose possibilities are numerous for electrical apparatus.

Wheeler Condenser & Engineering Co., Carteret, N. J., will exhibit in booth 64. Interesting tests of the Wheeler High Efficiency condenser will be released for information of visitors, and a new design of 2-pass condenser with heat transfer coefficient approaching that of a 1-pass will be announced. A feature will be a 2-stage air pump with inter and after condenser, also the pressure-sealed hot-well pump. A natural-draft, counter-current, enclosed cooling tower will be illustrated, also low-pressure, film type evaporators and a new high-pressure submerged type. Other apparatus shown will be closed bleed heaters, expansion joints, oil heaters and centrifugal pumps.

C. H. Wheeler Mfg. Co., Lehigh and Sedgeley Aves., Philadelphia, Pa., will have booth 77. Its display will include vacuum pumps, the Inter-after condenser, combined with the Radojet air removal pump and the Radojet Augmenter, operated by exhaust steam of 5 to 10 lb. pressure and used in connection with mechanically-driven air pumps to increase vacuum. The Froude type absorption dynamometer will also be shown.

The Whitney Mfg. Co., Hartford, Conn., will occupy booth 557. A motor-driven unit in operation will demonstrate the different sizes and styles of silent and roller chain for power transmission, also illustrating successive speed reductions from motor speed to practically zero.

Wickes Boiler Co., Saginaw, Mich., in its booth, No. 479, will have a lantern slide display of its product, installations and details of the Wickes boilers. Also literature will be available giving these details and a full description of the boilers.

The Williams Gauge Co., Pittsburgh, Pa., will have a display in booth 291, of its Stets system for boiler feed control for low and high-pressure work. Also will be shown special water columns for high pressures, high and low-water alarms, ball type gage cocks and pump governors.

The D. T. Williams Valve Co., Cincinnati, O., will have in booth 493, sectioned displays of its globe, angle, gate and check valves, also its new lines of Reverso and Iroverso globe valves with nickel discs and seats. It will have a complete line of its oil cups, grease cups, lubricating devices, gage cocks, boiler fittings and steam traps, arranged in groups on display boards for convenient inspection.

Wilson Welder & Metals Co., Wilson Bldg., Hoboken, N. J., will exhibit in space 485-486. In the display will be its arc welding machine of portable type, gasoline engine-driven and a similar machine motor-driven, both for single operator. Also various grades of color-tipt welding wire and samples of materials welded with the electric arc. Machines will be shown in operation demonstrating the welding process.

L. J. Wing Mfg. Co., 352 W. 13th St., New York, will present in booth 61 the Wing turbine blowers for forced draft in stokered and hand-fired boilers, with capacity as high as 1,300-hp.; the Type EM motor-driven blower for low-pressure boilers on heating systems, the larger units being also adapted for high-pressure boilers; Featherweight unit heaters for overhead suspension to heat industrial plants, leaving floor and window space unobstructed and avoiding accumulation of heated air in overhead spaces; Scruplex exhausters, a motor-driven, propeller fan, housed in but with motor outside the path of the air current; Scruplex direct connected propeller fans.

Wisconsin Electric Co., 70 16th St., Racine, Wis., will exhibit in booth 442. The display will include Dumore motor-driven grinders of portable and fixed types and Dumore fractional horsepower motors, 1/25 to ¼-hp. for driving small shop and household machinery.

T. B. Wood's Sons Co., Chambersburg, Pa., will have its exhibit in booth 474. This will include a line of power transmitting machinery such as collars, hangers, pillow blocks, pulleys, couplings, friction clutches and new line of flexible couplings and belt contactors.

Worthington Pump & Machinery Corp., 111 Broadway, New York, will occupy space 511-513. They will exhibit the cylinder, piston, piston rod and spray valve of their new double-acting, two-cycle Diesel Oil engine. This engine, built for the Shipping Board, has been in operation on a 30-day non-stop run under government supervision and several 10-day and longer period runs, totaling 1300 hr. or 7,375,000 revolutions under full load, without any replacement or repair. Other machinery exhibited will include the Worthington type OS centrifugal pump, a standard horizontal feather-valve air compressor, a vertical air compressor, a Deane pattern vertical triplex single acting power pump and a standard duplex piston pattern boiler feed pump. Water and Oil meters will also be displayed.

Wright-Austin Co., 315 W. Woodbridge St., Detroit, Mich., will show in booth 236, two entirely new products, an extra heavy water gage for steam boilers and a weighted try-cock. Other products displayed will be the monel metal whistle valve for safety alarm water columns, with reversible valve and renewable seat and the Brownie boiler low water signal for small boilers, a float chamber outside the boiler and in parallel with the water column. The new try-cock has monel metal valve and seat, both reversible and renewable without removal from the water column, and monel body for high pressures.

X Laboratories, 25 W. 45th St., New York, will have a display of the X boiler liquid for repairing leaks in low-pressure boilers and hot-water systems in booth 259.

Yarnall-Waring Co., Chestnut Hill, Philadelphia, Pa., will have in space 7A-7B its Yarway-Lee V-notch meter with mechanism exposed to show the recording and integrating action. It will also display the type B hollow-piston blowoff valve, balanced by admitting pressure to all sides. For extreme pressures, this is fitted with planetary gears and a crank on the hand-wheel to facilitate opening and closing. Yarway-Waring spray nozzles will also be shown.

Developed and Potential Water Power in United States

THROUGH THE Geological Survey, the Department of the Interior has brought up to date the Survey's records of developed water power in the United States. Table I shows that the total capacity of water wheels installed in plants of 100 hp. or more in the United States in March, 1925, was 10,037,655 hp., an increase of 951,000 hp. or nearly 10½ per cent over the total of 9,086,958 hp. in March, 1924. Of this increase 939,000 hp., or 99 per cent, was in public utility power plants and 12,000 hp., or 1 per cent, in manufacturing plants.

Table II shows the potential water power in the United States as computed and published in 1924. Studies of the installed capacity at fully developed water-power sites indicate that in general, the ultimate capacity of water wheels that may be installed at any power site will average about 130 per cent of the potential power available 50 per cent of the time. Therefore, to determine the capacity of the water wheels that may ultimately be installed in water-power plants in any section, the capacity of water wheels already installed should be subtracted from 130 per cent of the power available 50 per cent of the time as shown in Table II. The report also shows the figures for each state, but this tabulation cannot be given here.

TABLE I. DEVELOPED WATER POWER IN U. S. IN 1925 IN PLANTS OF 100 HP. OR MORE

Division	Total		Public utility and municipal		Manufacturing and miscellaneous	
	No. of plants	Capacity in hp.	No. of plants	Capacity in hp.	No. of plants	Capacity in hp.
United States		10,037,655		8,287,332		1,750,323
New England	1,230	1,398,603	251	656,270	979	742,333
Middle Atlantic	611	1,948,449	402	1,624,316	209	324,133
East North Central	346	884,760	6	641,445	121	223,315
West North Central	194	514,753	127	414,692	67	100,061
South Atlantic	----	1,589,304	----	1,352,478	----	236,826
East South Central	53	396,791	38	379,682	15	17,109
West South Central	29	31,317	14	27,105	15	4,212
Mountain	254	937,078	185	915,737	49	21,341
Pacific	299	2,336,400	244	2,255,606	55	80,794

TABLE II. POTENTIAL WATER POWER RESOURCES OF THE U. S.

Division	Available 90 per cent of the time		Available 50 per cent of the time	
	Hp.	Per cent	Hp.	Per cent
United States	34,618,000	100.00	55,030,000	100.00
New England	998,000	2.87	1,978,000	3.60
Middle Atlantic	4,317,000	12.40	5,688,000	10.35
East North Central	737,000	2.12	1,391,000	2.53
West North Central	871,000	2.50	1,844,000	3.35
South Atlantic	2,476,000	7.11	4,464,000	8.11
East South Central	1,011,000	2.90	2,004,000	3.64
West South Central	434,000	1.26	888,000	1.61
Mountain	10,736,000	30.83	15,513,000	28.19
Pacific	13,238,000	38.02	21,260,000	38.63

TABLE III. COMPARISON OF DEVELOPED WATER POWER, 1921 TO 1925

Division	Percentage of total in United States			Change:	
	1921	1924	1925	1921-1924	1924-1925
New England	16.5	15.3	14.0	-1.2	-1.3
Middle Atlantic	18.7	19.1	19.4	+ .4	+ .3
East North Central	9.3	9.1	8.9	- .2	- .2
West North Central	5.6	5.1	5.1	- .5	0
South Atlantic	13.6	14.3	15.8	+ .7	+1.5
East South Central	3.1	3.8	4.0	+ .7	+ .2
West South Central	.2	.2	.3	0	+ .1
Mountain	10.4	9.7	9.3	- .7	- .4
Pacific	22.6	23.5	23.3	+ .9	- .2

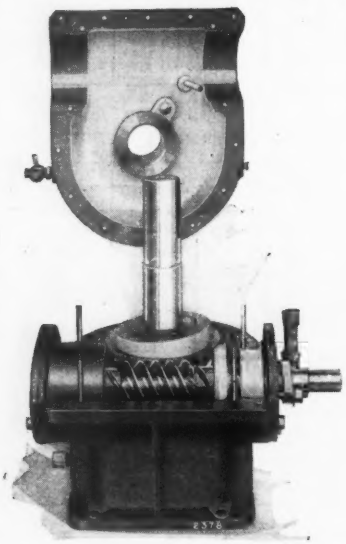
That water-power development in the Middle Atlantic States, South Atlantic States, and East South Central States is progressing more rapidly than in other sections of the country is indicated in Table III.

Vertical Shaft Driven Worm Reduction Gear

WORM reduction gears are reliabile, compact, and simple and also have the driven shaft at right angles to the driving shaft. Where the driven shaft is horizontal, this permits the motor to be located alongside the machine, instead of projecting out across aisle space. For vertical shaft drives, it is even more convenient, as it does away with bevel gears and vertical belts, hence it is ideal for vertical agitators, mixers, and similar machines.

Accompanying is an illustration of a worm reduction gear for vertical shaft drive recently developed by the De Laval Steam Turbine Co., of Trenton, N. J. The gear casing supports the worm bearings and also the lower bearing of the driven shaft, while the upper shaft bearing is held by the casing cover. Oil is carried at such a level that the worm and gear wheel dip into it, thus insuring copious lubrication, and the lower wheel shaft bearing, which is always immersed in oil, has spiral grooves to insure circulation of the oil.

To provide oil for the upper wheel bearing and thrust plate, a small reciprocating oil pump is incorporated in the



WORM REDUCTION GEAR FOR VERTICAL SHAFT DRIVE

casing cover, the plunger projecting downward against a vertical cam, which may be seen in the illustration just outside of the thrust plate of the bearing, the latter being recognizable by the two oil grooves. Suitable filling and drainage openings, together with a try-cock, provide for control of the oil level, so that inspection of the oil level at long intervals is about the only attention required.

For larger size reduction, where the worms run at fairly high speeds, it is not desirable to immerse the worm and wheel, on account of fluid friction, and a positive-pressure oiling system is used to feed oil to all the bearings and to the worm threads and gear teeth at the contact points. The shaft may extend either upward or downward.

"Union" Renewable Fuses Simplified in Construction

NEW DEVELOPMENTS in the design and construction of electrical fuses have been made recently by the Chicago Fuse Mfg. Co., of Chicago. It consists of modifications in the company's line of "Union" renewable fuses of the knife-blade type which make these fuses exceptionally simple in design and construction. This

FIG. 1. NEW UNION FUSE ASSEMBLED

development provides new features of durability and easy removal.

In the accompanying illustrations are shown the details of design and construction. When the fuse is taken apart for renewal of the fusible element, there are only three loose parts—the fiber case to which the threaded brass ends are securely attached; the knife-blades which are connected by a rigid fiber bar and to which the fusible element is bolted; and one of the loose screw caps which hold the knife-blade member in position.

To disassemble the fuse, it is merely necessary to unscrew the two caps and then slip out the entire knife-blade member after one end of it has been shifted slightly to get it out of its locked position. One of the caps can be removed, but the other is held on the knife blade by two nibs. Assembly is accomplished just as readily.

Extra heavy grey horn fiber is used in the construction of the case so that it will withstand the pressure developed by the blowing of the fusible element. The brass ends are securely attached to the fiber, and venting, which is an important feature of fuse operation, is accomplished by means of a number of grooves cut longitudinally in the fiber where attachment is made to the brass ends. After the ends are put on, these grooves become ducts which are large enough and of sufficient number to permit the escape of the gases caused by the volatilization of the fusible element and to relieve the case of the pressure generated. They are small enough, however, so that the flame is effectually quenched before it reaches the outside. These vents also prevent molten metal from getting into the threads of the caps and causing them to stick and make removal difficult.

The knife-blade member, to which the fusible element is attached, consists essentially of two sections of flat copper which are connected by a rigid fiber bar. These connections are made by means of rivets and screws. The assembly is so rigid and substantial that the copper blades are positively held in position and perfect alinement, assuring permanent contact with the clips. The connecting bar, which is attached by means of screws, may readily be replaced in the event of damage or breakage.

The fusible element makes direct contact with both knife blades and is held down at each end by a stud and washer. When making renewal, these studs need to be loosened only slightly and the fusible element, which is

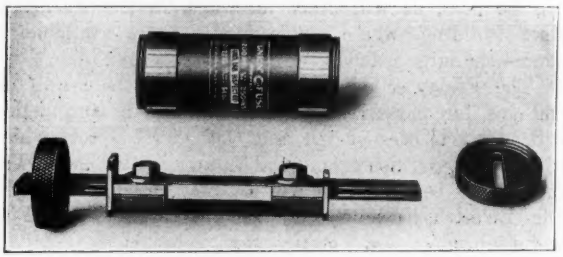


FIG. 2. UNION FUSE DISASSEMBLED SHOWING PARTS

notched at both ends, can be slipped in and the studs tightened; there are no through bolts, with heads that have to be held or nuts that can be lost or misplaced.

Midwestern Engineering Exposition

DURING THE week Jan. 25 to 30, 1926, engineers and managers interested in power making and its uses will have opportunity at the Chicago Power Show to study modern equipment.

Pumps for general use, boiler feed, vacuum heating, sewage and waste products and pneumatic sewage ejectors will be in evidence, one exhibitor in particular having planned a comprehensive display of pumps of all types for all purposes.

Steam pipe conduits for underground lines are being used extensively in heating systems and an interesting exhibit will be a new water-tight, high-efficiency conduit which requires little inspection.

In the pulverized fuel field will be shown by one exhibitor a complete machine demonstrating pulverization, the flow of coal and supply of primary air, all the inner workings of a pulverizing plant, arranged for convenient inspection.

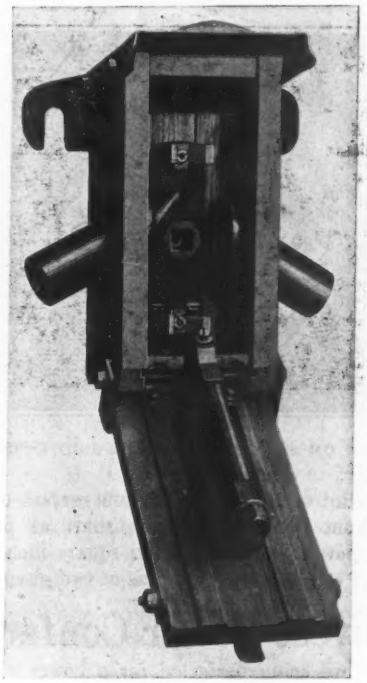
Older engineers will be interested in the progress shown since a mechanical show was held some 25 yr. ago on the Lake Front. Younger men will be able to get a comprehensive idea of present power machinery practice in a way that is possible only at a big exposition which brings all kinds of equipment together for study and comparison.

Power we must have to keep up modern civilization and supply the conveniences which have become daily necessities. Progress that is being made in power generation and distribution will be well symbolized by the pulverizers, economizers, air heaters and equipment for handling steam at 600 lb. or over which will be found on display at the Chicago Power Show.

Safety-First Fuse Box Prevents Contact with Live Parts

IMPROVEMENTS have recently been made in the design of fuse boxes for distribution transformers, so that it becomes impossible for the operator when re-fusing the box to come in contact with current carrying parts.

The new Westinghouse OD Safety-First Fuse Box, shown in the accompanying illustration, is of this type. It consists of a heavy, compact, moisture-proof box, fitted with special mounting brackets that permit it to be installed at the maximum distance below the transmission



SAFETY-FIRST FUSE BOX

wires. The door of the box is hinged at the bottom and is interlocked so that it can be removed or replaced only when the fuse tube is at a safe distance from the line contact. A screw driver to clamp the fuse link in the new tube is the only tool needed when re-fusing. To insert a new fuse the operator opens the door of the box which action disconnects the fuse and insulates it from the line. He then lifts off the door, inserts the refill in the tube, replaces and closes the door, and the box is again ready for operation.

ACCORDING TO statistics presented by Robert M. Davis of New York City at the meeting of the New England division of the National Electric Light Association in New London, Conn., Massachusetts is 60 per cent electrified in its industries and uses 956,000,000 kw.-hr. of central station energy per annum. This amount, he said, would be materially increased within the next five years. Massachusetts industries have a total of about 2,000,000 installed horsepower. The metals and transportation industries are 90 per cent electrified, he stated, textiles just under 50 per cent, paper manufacture 51.3 per cent, machinery 86 per cent. There are 1,035 private and 319 central station generating plants in New England at present.

Clutch Constructed So It Is Readily Accessible

POSITIVE release is a feature of the Hoerl friction clutch and cutoff coupling now being produced by The Wolf Co., Chambersburg, Pa. This clutch is made either as a coupling or with a sleeve for a pulley. It is compact in design, which makes it applicable in tight locations and where shaft space is limited. The clutch is engaged by the cone sliding along the shaft, causing levers to force the friction band against the inside of the shell rim. It can be engaged gradually or quickly, giving a clean release as soon as the lever is released.

WEAR ON THE CLUTCH LINING IS UNIFORM

On account of the entire friction surface being as far removed from the center of the shaft as possible, the maximum power is developed per square inch of contact. Adjustment can be made by means of two screws.

Midwest Power Conference

PLANS are being perfected for a power conference to be held in Chicago, January 26 to 29.

The committee in charge of the plans consists of:

Arthur L. Rice, Chairman

G. E. Pfisterer, Secy.

Karl A. Auty and L. M. Gumm, American Institute of Electrical Engineers

W. Sykes and W. R. Wright, American Institute of Mining Engineers

Tom Wilson and Alex D. Bailey, American Society of Mechanical Engineers

W. del. Carr and R. F. Schuchardt, National Electric Light Association

W. D. Keefer and J. I. Benash, National Safety Council

Walter A. Shaw and E. S. Nethercut, Western Society of Engineers

It is proposed that the first meeting, on Tuesday afternoon, shall take up the power resources of the country, both for steam and hydraulic power, that Wednesday morning be devoted to a general consideration of the best ways in which those resources may be utilized, and that Wednesday afternoon session take up the trends in economical power generation, dealing largely with the features to be found in big plants.

Economy in small plants is, however, quite as important, and the Thursday morning session will take up the problems of plant layout and equipment and plant operation in order to secure best economy in moderate sized plants, such as are commonly used in individual industries. The subject will be treated from the standpoint of both steam and hydraulic plants and in connection with this there will be also a talk and demonstration on the rendering of first aid.

Thursday afternoon has been left free for inspection trips to the power plants and developments in and about Chicago, and a subcommittee is arranging for these trips.

Thursday evening a dinner will be held, at which prominent speakers will take up the question of the effect of power generation, distribution and use on the social structure and on the economics of industry. This dinner will be held, as will other meetings, in the Furniture Mart Building, where ample facilities are available to handle the large attendance which is expected.

The Friday session will be devoted to the use of oil and gas for power generation. This is in conjunction with the activities of Oil and Gas Power Week, which will be observed throughout the country at that time. The subjects to be taken up will be the Diesel engine, the Diesel electric locomotive, the use of Oil as a Boiler Fuel and By-product Gas Plants.

It is expected that this will be the largest meeting devoted to the consideration of power topics which has ever been gathered together in this country and many prominent speakers have already accepted invitations to present papers.

Large Size Fuse Puller Made of Fiber

FOR REMOVING large fuses from line circuits, the Trico Fuse Mfg. Co. of Milwaukee, Wis., have developed a new "Giant Size" fuse puller and replacer. It is 12 in. long and made with 7 laminations of gray horn

NEW "GIANT SIZE" FUSE PULLER

fiber, securely riveted at all points subject to strain. Inserts placed between the laminations give a firm, even grip on the fuse and prevent any tendency to twist or slip in the hands of the user. This fuse puller and replacer is designed for use on fuses from 100—600-amp., 250-v., 60—400-amp., 600-v., making it a convenient tool for safely handling fuses of large capacity.

Williams Introduces Chrome-Molybdenum Steel Wrenches

CHROME-MOLYBDENUM steel is used in a new line of wrenches just introduced by J. H. Williams & Co., of Buffalo, N. Y. These tools will be marketed under the trade name of "Supperrench" and will supplement the company's Superior drop-forged wrenches of carbon steel. Chrome-Molybdenum steel makes possible a refinement in design and a decrease in weight impossible of attainment with carbon steel. The manufacturer states that the use of chrome-molybdenum makes possible far stronger tools of lighter weight and thinner section; their narrow, pointed jaws give efficient service in cramped quarters.

Pipe Joints Made Without Gaskets

DEFLECTIONS OF approximately 5 deg. are permissible in the pipe joints featured by the Midwest Piping & Supply Co. These joints are made up without gaskets, the design being such that the joint contact is between specially machined convex and concave spherical surfaces. This joint is made up by heating the ends of the pipe and then rolling them slowly for either the male or female part of the joint, care being exercised to get "full" dies so that the minimum lap thickness will be greater than the thickness of the pipe wall.

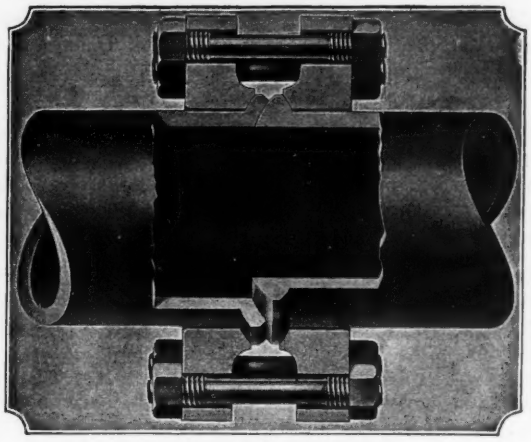


FIG. 1. PIPE ENDS ARE MACHINED FOR A METAL TO METAL CONTACT

Design of these joints further provides a tight joint and flange adjustment not only with correct pipe alinement but also when there are slight deflections in the pipe. The maximum flange bolting stress between the pipe ends of

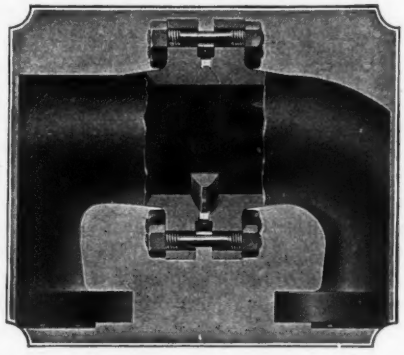


FIG. 2. STEEL RING CLOSES THE JOINT BETWEEN FITTINGS OR VALVES

the joint occurs near the inside of the pipe wall. Erection of this joint is simplified because the flanges swivel upon the pipe and neither gaskets nor field welding is required to make the joint tight.

STEAM REDUCING VALVES should be thoroughly cleaned and overhauled at least once every three months. The setting of reducing valves, however, should not be tampered with after once having been made.

A. S. M. E. Annual Meeting in New York Nov. 30 to Dec. 4

MONDAY, Nov. 30, will be taken up with registration council and committee meetings and Local Sections Delegates conference, with open house and a smoker in the evening. Tuesday morning, four sessions will be held at 9:30. One will be on oil and gas power with a paper by A. A. Raymond on Gas Engines of Maryland Plant of Bethlehem Steel Co., one by J. W. Morton and A. B. Newell on Auxiliaries for Motor Vessels; one by Hermann Lemp on Internal Combustion Engine Transmissions and one by F. Thilenius on Oil Engines as a Drive for Pipe Line Pumps. The second meeting will be on Machine Shop Practice with papers on Optical Methods for Measuring Machine Parts by Henry F. Kurtz and on Tensions and one by F. Thilenius on Oil Engines as a Drive A third meeting will be on Wood Industries, papers dealing with the Electric Molder by A. Jensen, Jr., with Shipping Containers by C. M. Bonnell, Jr., with High-Speed Motors by Charles Fair, with Methods of Glue Evaluation by W. L. Jones and with Spark Arresters by J. S. Mathewson. The fourth meeting will be a public hearing on Power Test Codes for Steam Turbines.

Tuesday afternoon at 2 o'clock will also have four sessions. The first meeting will be on Industrial Power, Higher Steam Pressures by Wm. F. Ryan and Supply of Power by W. H. Larkin, Jr. The second meeting will discuss Locomotive Boilers. The third will take up Centrifugal Compressors—for Refrigeration by W. H. Carrier and Testing by M. G. Robinson. The fourth meeting will be on Calculation Methods—Graphical by H. L. Seward and Special Slide Rules by G. W. Greenwood.

At 4:30 Hon. Herbert Hoover will deliver the Henry Robinson Towne lecture on Engineering and Economics.

Tuesday evening will be the award of Honorary Membership to Hon. Herbert Hoover and Past Pres. Worcester R. Warner, followed by the Presidential Address and Reception.

Wednesday morning's sessions will take up: First, Industrial Furnaces—Efficiency by V. J. Azbe and Fuels and Furnaces by W. Trinks. Second, Materials Handling —Problems and Their Solution by Frank D. Campbell and Safety by D. S. Beyer. Third, Shop Practice—Machine Design by F. E. Cardulls; Wear on Cast-Iron Gear Teeth by G. H. Marx, L. E. Cutter and B. M. Green; and Normal Pitch of Gears by G. M. Eaton. Fourth, Springs—Phosphor Bronze for Precision Instruments, by W. G. Brombacher; Manufacture of Small Steel Springs, by F. H. Brown; Weighing—Springs, by J. W. Rockefeller, Jr.; for Electrical Instruments by B. W. St. Clair; Design of Helical Springs of Rectangular Steel by C. T. Edgerton; and Fatigue and Elastic Results by T. McLean Jasper.

Luncheon of the Council and Student Branch Delegates will be held Wednesday Noon.

At 2 o'clock Wednesday afternoon will be heard the report of the Council, award of prizes and reports of the committee on engineering education and of the professional divisions. At 3 o'clock will be a meeting on Training for the Industries with paper on European Methods by Wm. E. Wickenden and one on Apprenticeship by Francis Mahoney. At the same hour will be a report on Steam Tables Research, and a Student Branch Conference. At 3:30 a ladies tea and reception will be given.

Wednesday evening will be the annual dinner at Hotel Astor.

Thursday morning a meeting will be devoted to Steam Power—Radiation in Boiler Furnaces by B. N. Broido; Developments at Colfax Station by C. W. E. Clarke; Steam Bleeding by C. D. Zimmerman; a Unit Pulverizer by R. Sanford Riley and O. Craig. A second meeting will be on Management—Plant Design and Efficiency by Harold T. Moore; Production in News-print Industry by George D. Bearce; Carbon Dioxide as Index of Fatigue, by Walter N. Polakov. A third meeting will take up Aeronautics—Progress at McCook Field by Lt. E. E. Aldrin; Place of Airship in Commerce by Lt. Col. H. H. Blee. A fourth meeting on Textiles will take up Individual Motor Drives, Wearing and Water Purification.

Thursday afternoon at 2 o'clock four meetings will be held. One on Power Plant Materials—Steel Castings for High Pressure Lines by A. E. White; Bolts for use in Power Plants by W. P. Wood; Furnace Refractories by E. B. Powell. One on Industrial Psychology—Its Present State by Lillian M. Gilbreth; Prison Industries by E. A. Doll. A third meeting will be on Lubrication—Graphical Study by H. A. S. Howarth; Oil Film in Bearings by G. B. Karelitz. The fourth will be on Design—Torsional Stress in Shafts by L. S. Jacobsen; Vibration of Steam Turbine Buckets by W. Campbell; Vibration of Shaft Passing Through Critical Speed by A. L. Kimball, Jr., and E. H. Hull.

At 4:30 Dr. Zay Jeffries will deliver the Robert Henry Thurston lecture on Engineering and Science.

Thursday evening a meeting will be held under the auspices of the National Defense Division.

Friday morning will be taken up with Council meeting, committee meeting and excursions.

News Notes

ADDITIONAL steam generating facilities for the Southern California Edison Co. are to be supplied by a new 50,000-kw. unit which is to be added to the company's present Long Beach Steam Plant at Long Beach, California.

The general type and plan of the new unit will conform to that of the two 35,000-kw. units which were built last year, the present structure containing these two units being enlarged to make room for the new unit. The boiler installation will include seven Stirling-type Connelly boilers with burners which may be quickly converted from natural gas burning to oil burning and vice-versa. The boilers are to operate at a steam pressure of 375 lb. and a temperature of 725 deg. F. Westinghouse condensers are to be used. General Electric switching equipment has been ordered. A single-cylinder type turbine with a rating of 50,000 kw., 50-cycle, 3-phase, 11,000 v. built by the General Electric Co. is to be installed.

Stone & Webster, Inc., who installed the two units last year at the Long Beach plant, is to have charge of the designing and construction of the new unit which it is estimated will cost approximately $6,000,000. It is expected that the new plant will go into operation July 1, 1926.

THE FRASER COMPANIES, LTD., of Canada will spend $2,000,000 in Maine in their development at Madawaska, on the international boundary line, according to Henry J. Harte of Bangor, Me., counsel for the companies, in a statement to the governor and council of Maine in making application for two pipe lines to transmit sulphite pulp in liquid form across the international bridge over the St. John River.

THE GIRTANNER ENGINEERING CORP., of New York, has opened a branch office at 141 Milk St., Boston, Mass., and D. A. Jenkins, who has been connected with the organization for the past few years, has been appointed district manager.

ANNOUNCEMENT is made by the Brown Instrument Co., Philadelphia, of the opening of an office in Indianapolis, Ind., 215 East New York St., with J. R. Green in charge, and another in Cleveland, Ohio, Hippodrome Building, with G. S. Frazee in charge.

THE LEAVITT MACHINE CO., Orange, Mass., has appointed the following representatives to cover Northern Ohio and Southern Ohio, respectively: The Ashmead-Danks Co., 7016 Euclid Ave., Cleveland, O., and Emil Werner, Woodlawn, Cincinnati, O.

THE UEHLING INSTRUMENT CO., of Paterson, N. J., recently appointed the Ernest E. Lee Co., 115 South Dearborn St., Chicago, as representative in Northern Illinois and Northern Indiana in connection with the sale of CO_2 recorders, fuel waste meters and other power plant instruments.

THE AMERICAN ENGINEERING CO., of Philadelphia, announces that its interests in Canada have been taken over by The Affiliated Engineering Companies, Ltd., with headquarters in the Southam Building, Montreal. This company has been formed by the merger of The Taylor Stoker Co., Ltd., of Montreal, and The Cleaton Co. (Canada), Ltd. M. Alpern, President of The American Engineering Co., is chairman of the board of the new company and F. S. B. Heward is president.

PLANS HAVE BEEN PERFECTED for a merger of four security and holding companies, controlling a number of power utilities, with the Mohawk-Hudson Power Corporation, Albany, N. Y., with the latter company authorized to take over and exercise the franchises and rights of the other interests. These include the Ontario Power Securities Corporation, Schenectady; Niagara Power Securities Corporation, Schenectady; Wanita Holding Corporation, New York City; and Adirondack Power Securities Corporation, Schenectady. The first noted organization is active with the second mentioned company, the Niagara Power Securities Corporation, in the control and management of the Niagara, Lockport & Ontario Power Co., Lockport. The other corporations control and operate the Utica Gas & Electric Co., Fulton County Gas & Electric Co., Cohoes Light & Power Co., Municipal Gas Co., of Albany, and the Adirondack Power & Light Corporation. The assets of the combined organization are said to total $300,000,000. Plans are under way for transmission line extensions for interchange of service and for generating plant, substation and miscellaneous expansion in the different districts. Charles S. Ruffner is president of the Mohawk-Hudson Co.

THOMAS FRANKLIN MANVILLE, Chairman of the Board of Directors of Johns-Manville, Inc., died at 6:45 p. m., Monday, October 19, 1925, in New York City. For the past 25 yr. Mr. Manville has been the directing head of Johns-Manville, Inc., during which time he has built up an outstanding organization fully capable of carrying on his plans and policies to even greater achievements. His brother, H. E. Manville, who succeeded to the Presidency of Johns-Manville, Inc., in 1924, was closely identified

with him during this entire period and will continue to direct the policies of the organization.

Mr. Manville was also President of the Arizona Asbestos Co., Treasurer and Director of the Asbestos Wood & Shingle Co., President and Director of the Canadian Johns-Manville Co., Director of The Fibre Corp., Director of the Fifth Avenue Bank, Trustee of the Franklin Savings Bank, President of the Board of Trustees of the Fifth Avenue Hospital, and President and Director of the Manville Securities Co.

BELL & GOSSETT Co. of Chicago has announced the establishment of an industrial instrument department which will handle the engineering phases of pyrometer installations.

C. C. McDermott, who was for 4 yr. with the Brown Instrument Co. at its Philadelphia factory and later in charge of Chicago territory and, later, was in charge of the pyrometer division of the Republic Flow Meters Co., will head the new department of the Bell & Gossett Co. R. E. Soules, for several years specializing in pyrometers will be associated with Mr. McDermott. A new and larger plant has been erected at 3000 Wallace St. where executive, engineering and production departments are brought together.

GEORGE E. CRISP, Treasurer of the Superheater Co., died after a prolonged illness at his home in East Orange, New Jersey, on Oct. 11, 1925. Mr. Crisp was born Feb. 16, 1870, and received his education at Albert Memorial College, London, England. He traveled extensively, in the United States and Canada and was identified with the early development of the Canadian Northwest. Mr. Crisp has been associated with the Superheater Co. for 10 yr. He was well known in the power equipment and railway supply field.

THE AIR PREHEATER CORP., 25 Broadway, New York, is a consolidation of the James Howden & Co. of America, Inc., and the Ljungstrom interests of Stockholm, Sweden. The newly formed corporation takes over all Ljungstrom patent rights of the preheater, together with the shops of James Howden & Co. of America, Inc., at Wellsville, N. Y. B. G. Brolinson has been elected president of the Air Preheater Corp. W. L. Batt, president of S. K. F. Industries is chairman of the board of directors.

THE FOXBORO CO., INC., of Foxboro, Mass., announces the transfer of its southern office to Atlanta Trust Bldg., Atlanta, Georgia. This office, which was previously situated in Birmingham, will be in the charge of A. W. Taber who has for several years been connected with The Foxboro Co. as a sales engineer.

FOLLOWING THE acquisition of the Western Power Corporation, San Francisco, Calif., by the North Amercian Co., Cleveland, Ohio, an expansion program has been determined, following along the lines heretofore advanced by the purchased company. The two main subsidiary organizations included in the deal are the Great Western Power Co., and the California Electric Generating Co. At different intervals along the North Feather River, it is proposed to construct a series of at least eight hydroelectric generating stations, of which two have now been completed, although not, as yet, operated at maximum capacity; these are the Caribou plant, near Lake Almanor, and the station near Las Plumas, near the foot of the mountain, each with rated outputs of 175,000 hp. The six additional plants now projected over a period of months will bring the total output to approximately 1,000,000 hp. Work is under way on an artificial lake, totaling about 29,000 acres, in the vicinity of Lake Almanor, for impounding waters for supply. The plans of the company include the development of hydro-electric power sites on the San Joaquin, Tule, Merced and Kern Rivers in Central California. The Kings River, also, is slated for immediate activity in this direction, where a hydroelectric power station of 500,000 hp. capacity will be located. Extensive transmission lines will be built.

THE YORK OIL AND CHEMICAL CO., a subsidiary of the York Mfg. Co. through whom the products of the former company will be marketed, has been incorporated in Pennsylvania and has completed a plant in York, Pa., for a new departure—specializing in the manufacture of oils for lubricating ammonia and carbon dioxide compressors in refrigerating plants. This step has been taken as the result of 2 yr. service and laboratory tests on oils by the lubrication and refrigerating engineers of the York Mfg. Co. in its test plant and in commercial plants.

The new building is 128 by 76 ft., containing offices, laboratories, boiler room and manufacturing space with capacity of 2500 gal. of refined oil a day. Five storage tanks of 12,500 gal. each will hold the stock oils.

Officers of the York Oil and Chemical Co. are Joseph L. Rosenmiller, Pres., Charles H. Ehrenfeld, Vice Pres., Thomas Shipley, Treas., Earle W. Gardner, Secy.

GEORGE M. BASFORD, consulting engineer of the Lima Locomotive Works and head of the G. M. Basford Co., industrial advertisers, New York, dropped dead in a New York Subway Station on Monday, Oct. 26, at the age of 60 yr. Mr. Basford's work was principally in the railway engineering field having been associated at various times with several of the leading railroad companies of the country, the Union Switch & Signal Co., the Hall Signal Co., the American Locomotive Co. and on the editorial staffs of several railway magazines. He was the organizer of the Locomotive Feed-Water Heater Co. which was taken over by the Superheater Co.

Books and Catalogs

ELECTRICAL MACHINERY ERECTION, by Terrell Croft; cloth, 6 by 8 in., 314 pages, 334 illustrations, first edition, 1925, New York; price, $3.00 net.

In this new book on Electrical Machinery Erection, Mr. Croft has recorded, classified and illustrated many of the "tricks of the trade" of the millwright and machinery erector, especially as they apply to the erecting of small and medium-sized motors, transformers and the like. The book is written for the man who must install the equipment. It should prove useful to the industrial plant engineer and his subordinates; the central station engineer will also find in it many points of value in the handling and erecting of his auxiliary equipment.

In the first division of the book, a discussion is given of the various methods of unloading and moving electrical machinery, involving the use of slings and tackle, cribs, skids and rollers. Details of supporting framework, methods of bolting to wood beams, posts and stringers and to steel and reinforced concrete beams, and construction of supporting platforms are discussed in full in the second division. Starting with the elementary operation of lifting the motor by hand, the third section explains the use

of skids, rollers, rope and chain tackles, lifting platforms, stagings and jacks for getting the motor into place. It also mentions briefly the methods of assembling and erecting motors that are shipped dis-assembled. Some information on transformer erection is also included.

Methods of lining up and leveling, maintenance, lubrication, babbiting and care of bearings form the subjects of the fourth and fifth divisions. The volume is copiously illustrated with line drawings showing the various methods and the details of machinery and equipment.

PULVERIZED FUEL, by W. F. Goodrich; 211 pages, 5¼ by 7¾ in., imitation leather; first edition; Philadelphia, Pa.; price $4.50.

The book contains 88 illustrations and 16 tables and is intended as a practical handbook on the subject. It is divided into six chapters, which deal with origin and history; American, French and British practice; design, equipment and operation; fuels suitable for pulverizing; and the future of pulverized fuel firing.

Most of the tables show data of evaporative tests at well-known plants, both in this country and Europe. Tables of coal analyses are also given.

It is comprehensive, though concise, and should be of material aid to power plant engineers in the selection and operation of pulverized fuel equipment.

MECHANICAL SOOT BLOWERS are considered an essential of every up-to-date power plant, hence, the new catalog of the Bayer Co. of St. Louis, Mo., will be found of prime interest. It describes the Bayer steam soot blower for horizontal, vertical and semi-vertical boilers, showing various styles of blower heads and valves and their action. The construction is fully illustrated and explained. Piping plans give the method of installation for different types of boilers, while details of the blower nozzles show how they should be placed to get the best results. The catalog may be obtained by writing to the Bayer Co. at St. Louis.

THREE NEW bulletins are being distributed by the Cooling Tower Co., Inc., 15 John St., New York. Bulletin No. 250 deals with the Spirodome nozzle used in connection with spray ponds for cooling circulating water for ammonia condensers, steam condensers, Diesel engines, etc. Bulletin No. 251 describes and illustrates the cooling towers built by this company and Bulletin No. 253 points out the distinctive features of the Tangldust air filter, suitable for use in cleaning air circulated through electrical machinery.

IN AN ATTRACTIVELY illustrated, 42-page booklet entitled Bearings and Their Lubrication, just issued by the Vacuum Oil Co., the principles of the lubricating oil film and wedge and the formation and maintenance of the oil film are discussed. Characteristics of lubricants, special examples of bearing lubrication and bearing troubles are also taken up.

ESTERLINE-ANGUS Co., Indianapolis, Ind., in an interesting bulletin on its twin-type meter, shows the arrangement and appearance of the device, sample, full size charts taken by it and the convenience with which charts are kept in vertical letter files on a desk file.

NEW METHOD of Balance Sheet Analysis is the title of No. 4 of the booklets on management methods published by the Metropolitan Life Ins. Co. of New York. It gives in detail a new method of studying the balance sheet of a company to determine the credit to which it is entitled and shows how this works out for a given case. The method is well worth the attention of those who have occasion to decide on the credit which should be given to a firm or the condition of its affairs.

ROBINSON VENTILATING Co., Pittsburgh, Pa., is distributing its bulletin No. 1000, dealing with Robinson forced and induced draft fans.

GALVANUM, a paint for galvanized iron surfaces, is described in a folder and color card recently received from Goheen Corp'n., Newark, N. J.

THE FROST MFG. Co., of Galesburg, Ill., has recently issued its catalog No. 4-A, dealing with Ross steel boilers. This catalog gives colored illustrations showing the passage of gases from the furnace to the flue and also contains a table of dimensions for different sizes of boilers.

THE BROWN INSTRUMENT Co., Philadelphia, Pa., has recently issued two catalogs which will prove of interest to power plant engineers—No. 44 illustrating and describing Brown electric tachometers and No. 74 dealing with Brown recording pressure and vacuum gages.

BULLETIN No. 4, published by the Alberger Heater Co., Buffalo, N. Y., describes Alberger-Buffalo heaters, coolers, economizers, vapor condensers and heat interchange equipment. It is well illustrated with halftones and points out the uses to which the various types of equipment are suited.

HOMESTEAD VALVE MFG. Co., Homestead, Pa., is distributing an attractive circular showing the construction of the Homestead protected seat hydraulic operating valves. This circular describes the construction in some detail and points out improvements which have recently been made.

GOULDS MFG. Co., of Seneca Falls, N. Y., is sending out a folder in which attention is called to the pumps manufactured by that company for waterworks filtration plants, sewage disposal and emergency fire service; also to its series of bulletins on centrifugal and triplex pumps and on pump data.

THE D. O. JAMES MANUFACTURING Co., Chicago, announces its new general catalog No. 99 of 288 pages which covers its complete line of gears, reducers and couplings. It is fully illustrated and contains many pages of general engineering data which is of interest to engineers, designers and purchasers of transmission equipment.

"CAPACITORS" is the title of a 24-page bulletin from the General Electric Co., describing the value of this device in power factor correction on electric generating and distribution systems and for direct installation at motor terminals on low voltage circuits. Details are given as to operation, location, etc. Illustrations in the form of charts, diagrams, tables and photographs are used. The bulletin bears the designation GEA-77.

FOXBORO INDICATING THERMOMETERS are described in Bulletin No. 148, which is the latest catalog from the Foxboro Co., Foxboro, Mass. These thermometers are of the dial type, using either vapor or gas pressure as the working medium, and can be arranged to give reachings at some distance from the location of the bulb. Details of their construction are described and many industrial applications are illustrated.